

The Atlantic

A FIGHTER PLANE THAT'S TOO CHEAP / THE LOSS OF COUNT BASIE

UNDERSTANDING TELEVISION

BY DAVID MARC

AS ROLAND BARTHES, JEAN-LUC GODARD, AND THE FRENCH DEVOTEES OF JERRY LEWIS HAVE REALIZED FOR YEARS, TELEVISION IS AMERICAN DADA, CHARLES DICKENS ON LSD, THE GREATEST PARODY OF EUROPEAN CULTURE SINCE THE DUNCIAD. YAHOOOS AND HOUYHNHNMS BATTLING IT OUT NIGHTLY WITH SUBMACHINE GUNS. SEX OBJECTS STORED IN A BOX. ART OR NOT ART? THIS IS LARGELY A LEXICOGRAPHICAL QUIBBLE FOR THE CULTURALLY INSECURE. INTERESTING? ONLY THE HOPELESSLY GENTEEL COULD FIND SUCH A PHANTASMAGORIA FLAT.

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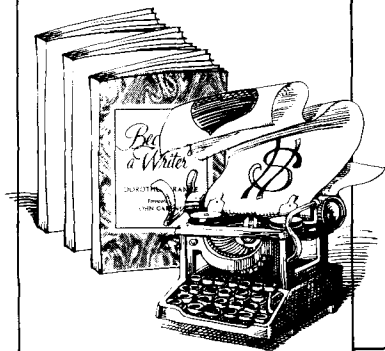
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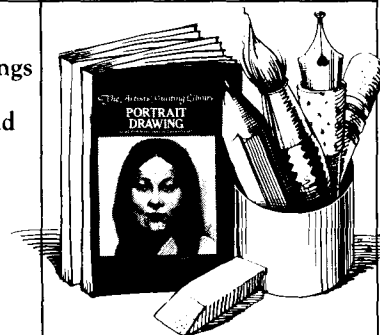
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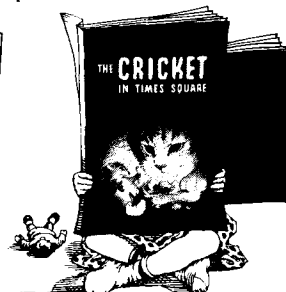
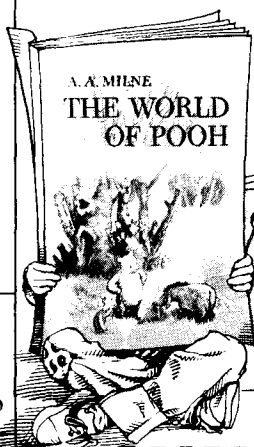
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ARTICLES

- 33 UNDERSTANDING TELEVISION** **DAVID MARC**
The "most effective purveyor of language, image, and narrative in American culture" is still more reviled and laughed at than seriously examined

- 46 THE AIRPLANE THAT DOESN'T COST ENOUGH** **GREGG EASTERBROOK**
A good fighter, designed by the Northrop Corporation, is not in production because the Pentagon, for bureaucratic reasons, doesn't want it

- 66 HOW THE UNIVERSE WORKS** **ROBERT P. CREASE AND CHARLES C. MANN**
The ultimate goal of physics is a theory that explains all matter and energy. Today physicists may be close to achieving that goal, in large part because of the efforts of Sheldon L. Glashow

REPORTS & COMMENT

- 14 NOTES: COMMA 1884** **NICHOLSON BAKER PETER BAIDA**
- 18 ALASKA: NIGERIA OF THE NORTH** **JAMES FALLOWS**
- 22 WASHINGTON: A BIPARTISAN FOREIGN POLICY** **JEFFREY E. GARTEN**
- 24 BRAZIL: A NEW GIANT IN THE ARMS INDUSTRY** **JOHN HOYT WILLIAMS**

HUMOR AND FICTION

- 30 MUSEUMS, NO** **ROBERT M. STROZIER**

- 45 AFTERNOON** **GUY BILLOUT**

- 60 FIRE BLIGHT** **JOYCE KORNBLATT**

POETRY

- 50 THE STORM** **ELLEN BRYANT VOIGT**

- 88 THE WINDOWSILL OVER THE SINK** **VERN RUTSALA**

BOOKS

- 104 LOOSE TALK ABOUT NUCLEAR POWER** **RICHARD WILSON**
The Cult of the Atom by Daniel Ford
The War Against the Atom by Samuel McCracken
How Safe Is Nuclear Energy? by Sir Alan Cottrell

- 109 AN OBSCURE LIFE** **PHYLLIS ROSE**
The Letters of Jean Rhys edited by Francis Wyndham and Diana Melly

- 112 BRIEF REVIEWS** **PHOEBE-LOU ADAMS**

OTHER DEPARTMENTS

- 5 LETTERS TO THE EDITOR**
- 95 MUSIC: THE LOSS OF COUNT BASIE** **FRANCIS DAVIS**
- 98 FOOD: SUMMER ICES** **CORBY KUMMER**
- 101 SPORTS: BOXER WITH A FUTURE** **G. A. TAUBES**
- 116 THE ATLANTIC PUZZLER** **EMILY COX AND HENRY RATHVON**

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LETTERS TO THE EDITOR

SPOCK ON SCHOOLS

Benjamin Spock ("School Reform: Coercion in the Classroom Won't Work," April *Atlantic*) is quite right in his criticisms of the report of the National Commission on Excellence in Education, but quite wrong in his own prescriptions for the improvement of education. Spock has proposed a "methods" solution to the problem and has created the impression that this solution has not been tried, which leads me to wonder when Spock was last in the vicinity of a public school.

The history of education in both Canada and the United States in the past several decades has been one of experimentation with a number of methods, including Spock's favorites (learning by doing, teachers as presiding officers, emphasizing imagination and creativity, and so forth). Teacher training today is an almost constant exhortation to the prospective teachers to employ these methods as well as many others (this has been the case for at least two decades). Teachers leave the university with an impressive armamentarium of "methods"; research shows that most teachers, in fact, do employ Spock's methods and many more as well. Accordingly, the quality of public education should have steadily improved over the past two or so decades. Sadly, the exact reverse is the case. But how can this be?

Quite simply, the "methods" solution is inappropriate and ineffective. Voluminous research, emanating from the United States, Canada, Great Britain, Australia, and elsewhere, has taught us that the particular methods employed by teachers make little or no difference in how well their students learn. An important fact has emerged from this research, however: teachers make a difference. Some teachers are extremely effective regardless of their methods, while others are ineffective regardless of theirs.

CLAUDIO VIOLATO
*Department of Teacher
Education and Supervision
The University of Calgary
Calgary, Alberta*

Dr. Spock may be the expert, but I am a teacher. I have taught in three different states during the past eighteen

years, and I know that he is wrong.

First, it has been many years since students had to repeat clumsy definitions on demand, or diagram sentences according to Latinate analyses of English. As far back as thirty years ago much more functional language textbooks became popular.

Second, even authoritarian teachers can be, and often are, loving and kind. They simply provide a more structured environment than some of their colleagues do. It is the very students whom Dr. Spock mentions—those who have met with family crises and parental neglect—who often respond best to clear regulations, firm enforcement, and a strong sense that certain actions lead invariably to predictable results.

Third, the hurdles over which "everyone, of no matter what capability, must jump" in order to be promoted have not existed in such rigid form for at least a generation. Everywhere I have ever been there were different groups who had different tasks and were expected to achieve different goals. Children with learning disabilities are usually identified and helped, not ignored and rejected.

Fourth, Dr. Spock has taken the National Commission's word "homework" and quietly slipped in the adjectives "conventional, repetitive." When students are asked to invent original metaphors, or write humorous poems, they are learning conventional forms, but the work cannot possibly be considered repetitive. Why does he think that work that "fosters self-reliance in thinking" does not already take place?

Fifth, although Dr. Spock considers grading "an abomination," many people, including students, find it useful. Grades do signify something, especially beneath the rarefied level of medical schools, and it is not simply "the ability to memorize." They represent an amalgam of effort, ability, and originality.

Sixth, it is simply not true that "medical education provides a useful focus for evaluating teaching methods." Students at that level of education differ from my own both in ability and in motivation. Approaches that are suitable for them do not necessarily work equally well with less intelligent or less eager children.

Seventh, Dr. Spock may know some

snobs, but I am one of those “academic teachers in high school,” and I constantly urge my students to take practical courses like typing. I consider certain practical skills to be necessities of modern life, as do most of my colleagues.

RUTH COOPER
Salem, Mass.

WEST BANK PROBLEMS

In his article “A Stranger in My House” (June *Atlantic*) Walter Reich makes concluding suggestions that ignore the content of his interviews. His hope that the West Bank Palestinians would settle for only a West Bank state ignores their consistently stated dream of repossessing all of western Palestine. If the Israelis compromise on establishing such an Arab state in the heart of the original Promised Land, they will not only jeopardize their future security but also forsake their religious purpose which is their identity as Jews.

One of the Israelis interviewed said, “We have bridged time.” This is the crux of the problem. The Jewish faith is immutable. It does not adapt to civilized progress, transient social customs, or the evolution of political ethics. If Israel is to continue to exist, a solution for the Palestinian problem is not to be found in negotiations or treaties.

It will not be a statesman who resolves the problem. It will be a warrior.

STEPHEN E. SCHLARB
Midland, Texas

Walter Reich provided some fascinating insights into the thinking of Israelis and Palestinians concerning the West Bank, but his article contains at least one inaccuracy. The statement (made by an Israeli) that “the only free Arab press in the Middle East is right here in Jerusalem” is absurd.

In fact, all materials intended for publication in Palestinian newspapers must be approved by the Israeli censor. Penalties for violation are suspension of newspaper publication and/or arrest of the editorial staff. Subjects censored include not only support for the PLO and calls for the end of the military occupation but also any topic dealing with the rights of Palestinians and any factual news (killings of Arabs by Israelis, for example) that the Israelis find objectionable.

I find little to distinguish West Bank Palestinians, who are denied all political and most other civil rights, from blacks

in present-day South Africa or Catholics in eighteenth-century Ireland.

GEOFF LOCANDER
Dallas, Texas

Walter Reich replies:

Mr. Schlarb attributes to me a suggestion I didn't make. I didn't suggest the establishment of a West Bank Palestinian state. I merely observed that if the West Bank Palestinians were willing to cut themselves free of the PLO line and to accept Israel within its pre-1967 borders, and if they offered to negotiate with the Jewish state, then many of the Israelis who have feared the consequences of an Arab-Israeli accommodation on the West Bank would suddenly have less to fear; those Israelis might then be willing to see the West Bank Palestinians given political independence in an overall accommodation that might also give Jews the right to settle in the area. I didn't say that such an accommodation would work, that the lessening of fear would prove justified, or that the Palestinians wouldn't in the end try to use the West Bank as a springboard to destroy Israel. I simply tried to indicate what the West Bank Palestinians might be able to achieve if they were willing to speak and negotiate for themselves.

To Mr. Schlarb's suggestions for a solution I can respond only with a shudder. In fact, only a few Israelis advocate force to solve the West Bank problem—namely, the followers of Meir Kahane, who believe that the Arabs should be expelled to the surrounding Arab countries, and who number at most a few dozen Jews in a country containing nearly four million. The very great majority of Israelis—even Israeli settlers in the West Bank—believe that the Arabs in that area should be allowed to stay and should be accorded full civil rights. Ironically, some of the strongest support for the expulsion of those Arabs, and for the use of force as Mr. Schlarb urges, has come not from Israelis but from American Christian fundamentalists, who believe that the Second Coming will not occur until Jewish sovereignty is restored to all of the Land of Israel and the Jewish Temple is rebuilt on its original site, which happens now to be occupied by the Islamic Dome of the Rock.

As for Israeli censorship, it's true that my source was overstating the case. The Arab press in the West Bank and East Jerusalem is required to send all materials intended for publication to the Israeli censor, and the censorship is heavy; but the censor does not automatically reject calls for the end of the military occupation, articles on topics dealing with the rights of the Palestinians, or factual news that the Israelis find objectionable.

Israeli censors routinely forbid the publication of articles, in both Arab and Israeli publications, that in their judgment compromise national security. In addition, they forbid calls, in either newspapers or books, for the elimination of Israel or for the creation of circumstances that would in their view result in the elimination of Israel; they consider calls for the establishment of a PLO-run state to be impermissible on the grounds that the PLO favors the destruction of Israel. And they do not permit West Bank and East Jerusalem newspapers to publish articles that would in their judgment constitute an incitement to riot, inflame nationalistic feelings, or deny the legitimacy of Israel. Nevertheless, the Arab press manages to get around much of this censorship by reprinting articles from the Israeli press that articulate or support their position—of which articles, in the contentious mass of Israeli newspapers, there are many. In general, despite the censorship, much of what appears in the West Bank and Jerusalem press is pointedly critical of Israeli policies and behavior, and obviously sympathetic to the PLO.

This state of affairs can easily be confirmed by reading a copy of the English-language Al Fajr Jerusalem Palestinian Weekly (available in the United States from the newspaper's office at 2025 I Street, N.W., Suite 925, Washington, D.C. 20006). The reader will find numerous articles specifying human-rights violations against Arabs, criticizing the military occupation, and reporting enthusiastically on the activities of the PLO.

U.S. AID TO AFRICA

Jack Shepherd's article on the African food crisis (“Drought of the Century,” April *Atlantic*) misrepresents the United States' very good record of response to the African food crisis. Some examples:

Shepherd: “Every year since Reagan took office, however, he has decreased food aid to Africa. This fiscal year, the Reagan Administration again cut Food for Peace, from an already modest \$219 million to \$204 million.”

Fact: In 1984 (all years are fiscal years) the value of our Food for Peace commodity allocations for Africa stands at almost \$316 million—a 50 percent increase over that for 1983 (\$210 million), and a 61 percent increase over that for 1982 (\$196 million); this year's level will exceed the previous high level, reached during the worst Sahelian drought year, 1974. The United States also pays ocean

freight costs of shipping food to Africa; in 1984 these will exceed \$122 million.

Shepherd: "A separate food-aid program that covers emergencies like the one in Africa was also cut, from \$84 million to \$72 million."

Fact: We have increased the value (commodities only) of emergency food aid for Africa this year to more than \$106 million, from \$34 million in 1983 and \$28 million in 1982. Ocean-transport costs for emergency shipments will total another \$68 million in 1984.

Shepherd: "[The Administration] promises a total of 187,000 tons of U.S. food for Africa by next October."

Fact: This Administration has already committed food aid for sub-Saharan Africa totaling more than 1.2 million tons this year.

Shepherd: "[The UN Food and Agriculture Organization estimates that] 4 million tons of emergency food aid are urgently needed."

Fact: The FAO estimate of the total amount of food aid needed by the drought-affected countries of Africa is 3.26 million tons. This is not based on emergency needs; the FAO does not separately estimate emergency food aid

required to prevent starvation and severe malnutrition. Rather, the FAO calculates the total food-aid requirement as cereal import requirements less what can be imported commercially.

Shepherd: "The West, including the United States, has been very slow to help Africa meet its short-term needs. . . . By February of this year, international pledges of food totaled just half of the needed 4 million tons."

Fact: On March 13, 1984, the FAO reported that international donors had committed nearly 2.3 million tons of food aid for the affected countries, well over two thirds of the 3.3 million tons that the FAO estimates are required to meet both extraordinary and longer-term needs. The donor community has already allocated 35 percent more food for these countries than it provided in all of last year. (Of the 2.3 million tons committed by all donors, Russia had pledged twelve thousand; Shepherd, however, faults only the West.)

Shepherd: "Moreover, USAID, the agency that handles U.S. food aid, has also been slow to respond to the starvation. . . . By the end of last year, the agency had approved aid for just eight of

the twenty-two African nations where people are starving."

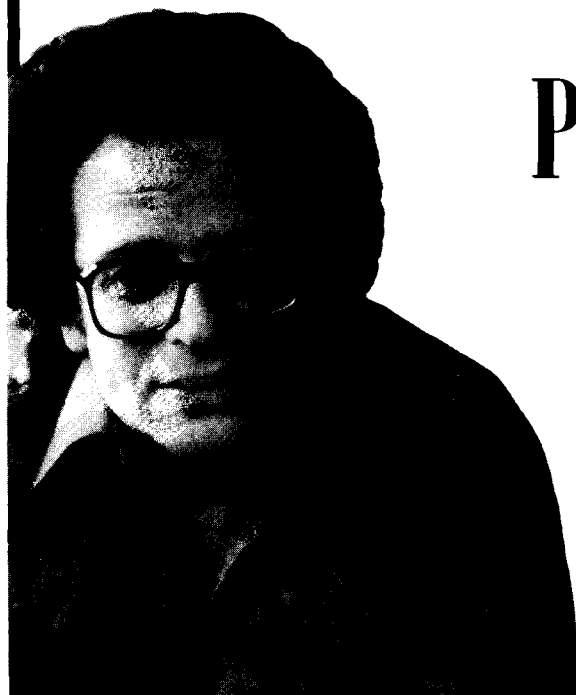
Fact: In 1984 USAID has approved food aid for all twenty-four (not twenty-two) of the FAO-priority countries. By the end of 1983 we had approved food aid for eighteen of the twenty-two countries then on the FAO's list. As of April 18 we had approved 83 percent of the food aid for which we had received actionable requests.

Shepherd's article also impugns the motives of the United States in providing food aid to Africa, relying on misinformation to make his case. In charging that U.S. aid policy is shifting from humanitarian and developmental concerns to political and strategic preoccupations, he alleges that from 1981 to 1983 the Reagan Administration cut food aid to Africa by more than a third. The truth is that food aid for sub-Saharan Africa increased by 20 percent last year, when it reached one million tons, and this year it will climb by at least another 20 percent, and exceed 1.2 million tons.

Shepherd says the Administration's request for a \$90 million supplemental appropriation for Africa was to "postpone further action." In fact the supple-

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mental was quickly approved, and the additional food aid it will buy is being shipped to Africa now.

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M. PETER MCPHERSON
Agency for International Development
Washington, D.C.

Jack Shepherd replies:

Mr. McPherson argues that the Reagan Administration and USAID have responded quickly and generously to African starvation. I disagree—and so do fifteen U.S. senators, ninety-six U.S. representatives, the staffs of several voluntary international-relief agencies, and the public record. What Mr. McPherson undertakes here is a revision of history.

I argued that the Reagan Administration and USAID cut food aid to Africa during the past three years for political and economic reasons. When the facts of widespread starvation were presented to this Administration by Congress and the press, USAID and other Administration officials were slow to restore aid and get on with the emergency feeding of 150 million starving people.

Now, more than nineteen months after being alerted, USAID finally has its food-aid shipments moving toward levels that should have been offered immediately.

On August 4, 1981, Mr. McPherson joined President Reagan in the Rose Garden of the White House to announce, amid much laughter, a cut of \$28 million in foreign aid for twelve of the world's poorest nations, most of them African.

That was just the start. The budget requests to Congress by Mr. McPherson's own agency document the progression of food-aid cuts. In USAID's Congressional Presentation for FY 1984, for example, both the Main Volume and Annex I/Africa clearly show the levels of aid under PL 480 decreasing in fiscal years 1982 and 1983 and projected decreases for 1984. Similar information is available in U.S. Overseas Loans and Grants and Assistance From International Organizations, July 1, 1945–September 30, 1982. The drop in emergency food-aid requests granted can be found on page 19 of the Annex I/Africa. A similar pattern is shown in FATUS: Foreign Agricultural Trade of the U.S., Jan./Feb. 1983.

These figures were corroborated with staff members of the House Subcommittee on Africa and other sources.

To get a sense of what the Reagan Administration has been up to, look at page 171 of the Congressional Presentation. Despite several months of alerts about starvation in

Ethiopia, USAID requested that no food aid be sent to that nation in fiscal year 1984. That is, had Mr. McPherson's request stood, food aid to Ethiopia would have gone from 8,172 metric tons in 1982 to zero in 1984. Pressure from Congress and the press restored those food shipments in the face of great reluctance on the part of the Reagan Administration.

Were USAID and the Reagan Administration acting swiftly and generously? Consider the following chronology:

USAID ignored requests to send food to Ethiopia from November of 1982 through July of 1983. A private letter to me, dated August 31, 1983, from the Catholic Relief Services, said: "We have been agonizing since November, 1982, as to how to get the administration to turn around on its position. Our November request to USAID for 838 [metric tons] for distribution in [a province of Ethiopia] did not receive a favorable response until May, 1983."

On October 18, 1983, the UN Food and Agriculture Organization announced that twenty-two African nations were facing "catastrophic" food shortages and would need three million tons of emergency food aid.

On December 13, 1983, Representative Guy V. Molinari, of New York, wrote in The New York Times, "According to officials at the Office of Food for Peace (USAID), our major program for food assistance, slightly over \$25 million in food aid has already been processed. This amounts to 71,363 metric tons for emergency relief programs to eight African countries affected by the drought."

By December of 1983 a group of private voluntary-relief agencies had complained publicly that the Reagan Administration was not moving fast enough on food aid to Africans. This protest was joined by Representative William H. Gray III, of Pennsylvania, who urged "swift and organized action" by the go-slow Reagan Administration to get food into Africa.

In January of 1984, shortly before my article went to press, Secretary of State George Shultz announced that U.S. food aid to Africa would reach 187,000 tons for the year. The New York Times (January 15, 1984) stated, "Total American food aid for Africa is 187,000 tons for the current fiscal year."

A strange process now unfolded. With pressure mounting, the Reagan Administration announced on January 30 that it would seek a supplemental appropriation of \$90 million for African aid. Members of Congress called the amount too small and sponsored a bill that gave \$150 million. The bill passed the House but was slowed to a halt in the Senate when the Reagan Administration

attached to it a controversial amendment calling for military aid to El Salvador and insurgents in Nicaragua.

Senator John Danforth, of Missouri, fearing that African food aid would disappear in wrangles over Central America, freed \$90 million by attaching it to a bill to subsidize domestic heating, and it was passed and signed by the President in March. This is the \$90 million that Mr. McPherson claims was "quickly approved" and is on its way. The other \$60 million remained stuck with the Central American military attachments and in June was awaiting action by a conference committee.

On March 5, ninety-six members of the House of Representatives—including eleven Republicans—signed a letter to President Reagan asking for immediate emergency grain shipments to Africa. Specifically, they asked the President to free 300,000 tons of grain from the Emergency Wheat Reserve.

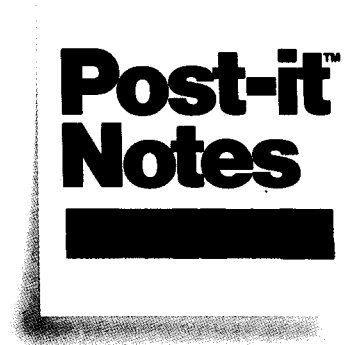
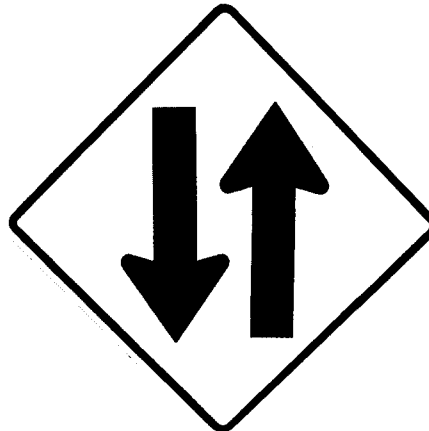
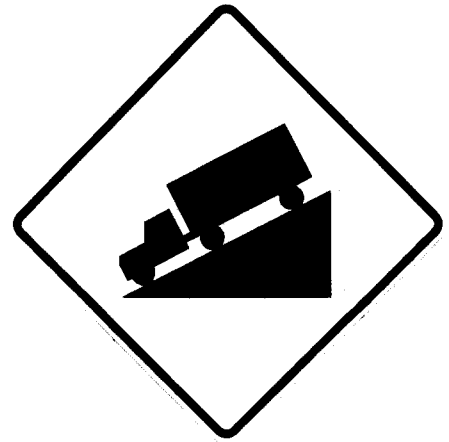
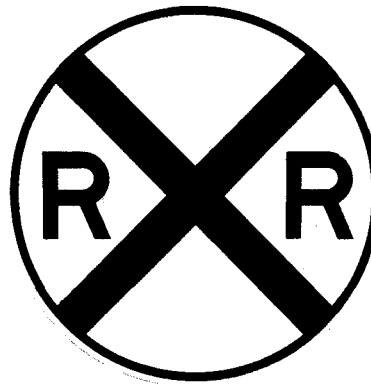
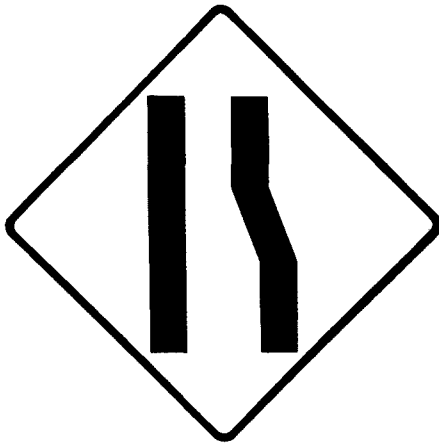
Mr. McPherson states that the FAO requested 3.26 million tons of food aid for Africa. Africa News (April 2, 1984) put the figure at 3.35 million, probably more accurate than the estimate (four million) I used. Mr. McPherson states that as of this spring USAID had "committed" itself to 1.2 million tons of food aid for sub-Saharan Africa. This figure would be commendable if correct. But, according to relief-agency reports and congressional staff members, by April 5 USAID had provided \$124 million in food aid to Africa, or about 329,000 metric tons. This represents less than ten percent of the need. With current appropriations, the figures may rise to about 560,000 metric tons and 17 percent.

MORE ENDLESS SPENDING

In his April article "Endless Spending" James Fallows endorsed some Grace Commission "findings" on civil-service retirement that do not withstand examination.

First, he stated that civil-service retirement now costs roughly \$22 billion per year. The President's budget shows that in fiscal 1983 the CSRS fund paid \$20.3 billion in annuities, yet in the same year the fund received \$18.1 billion from worker-employer contributions and interest on fund assets, and civil-service retirees returned approximately \$2.5 billion in income taxes.

Second, he stated that federal pension programs are more generous than any others ever devised. All evidence to date indicates that the benefits offered by most company plans, when combined



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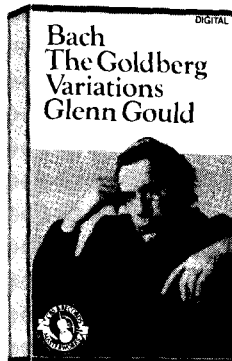
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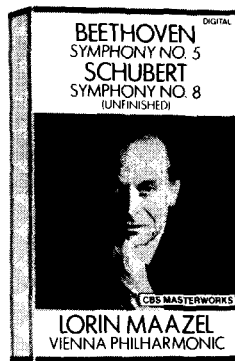
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230433. **Dvorak: Symphony No. 9 (New World)**—Bernstein and New York Phil. (Columbia)

GERSHWIN

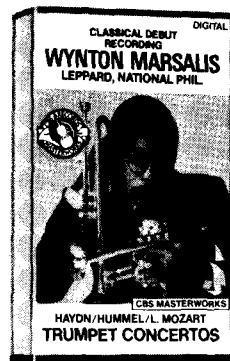
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308072. **Haydn: Cello Concertos in G & D Major**—Yo-Yo Ma and the English Chamber Orch. (Columbia)
257956. **Haydn: Symphonies No. 101 (Clock) and No. 103 (Drum Roll)**—Bernstein, New York Phil. (Columbia)

MAHLER

314369. **Mahler: Symphony No. 1 (Titan)**—Maazel, Orch. Nat'l de France (CBS Masterworks)
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321851

MOZART

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318311. **Mozart: Symphonies 36 (Linz) 38 (Prague)**—Rampal, Mostly Mozart Orch. (CBS Masterworks)
314955. **Mozart: Symphonies No. 40 & 41 (Jupiter)**—Szell, Cleveland Orch. (CBS Great Performances)
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317677. **Schubert: Symphony No. 8 (Unfinished); Rosamunde Overture and Ballet Music**—von Karajan, Berlin Philharmonic (Angel)
321729. **Schubert: The Impromptus, Op. 90 & 142**—Murray Perahia, piano (Digital—CBS Masterworks)

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312777. **Tchaikovsky: Capriccio Italian; Rimsky-Korsakoff: Capriccio Espagnol**, etc.—Bernstein (CBS Great Performances)
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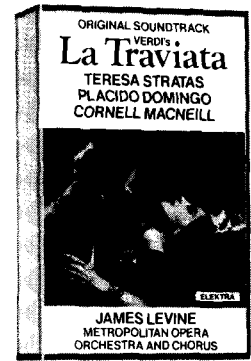
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300509. **Prokofiev: Peter And The Wolf; Britten: Young Person's Guide To The Orchestra**—Will Geer narrates; Somary conducts (Vanguard)
318691. **Prokofiev: Love For Three Oranges Suite; Lt. Kije Suite**—Thomas, L.A. Phil. (CBS Masterworks)
320564. **Ravel: Concerto For Left Hand; Rapsodie Espagnole; Alborada Del Gracioso**—Fleisher, piano; Comissiona, Baltimore Sym. (Digital—Vanguard)
318451. **Ravel: Bolero; Pavane; Daphnis Et Chloe—Suite No. 2**—Andre Previn, London Symphony (Angel)
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281493. **Stravinsky: Rite Of Spring**, Zubin Mehta, N.Y. Phil. (Columbia)

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305698. **Berlioz: Symphonie Fantastique**—Maazel, Cleveland Orch. (Columbia)
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245043. **Rachmaninoff: Piano Concertos No. 1 & 2**—Ashkenazy; Previn, London Symphony (London)

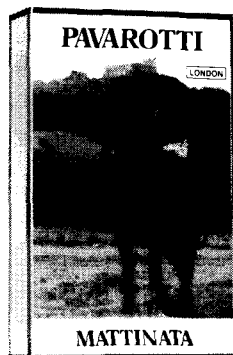
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318824. **Schumann: Symphony No. 4; Mendelssohn: Symphony No. 4**—Tennstedt, Berlin Phil. (Digital—Angel)
225888. **Smetana: Moldau, Bartered Bride Overture, Dances; Dvorak: Carnival Overture**—Bernstein, N.Y. Phil. (Columbia)
- 310870-390872. **Johann Strauss' Greatest Waltzes** Ormandy, Szell, Bernstein (Count as 2—Columbia)
320424. **Richard Strauss: Ein Heldenleben**—Dicterow, violin; Mehta, N.Y. Phil. (Digital—CBS Masterworks)
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323733. **Wagner: Orchestral Music from "The Ring"—Ride of the Valkyries**, etc. Mehta and New York Phil. (Digital—CBS Masterworks)
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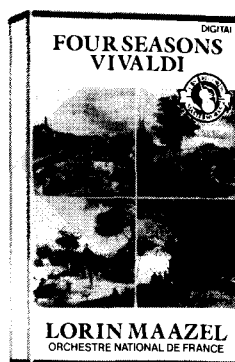
311472. Plácido Domingo With John Denver—Perhaps Love. Also: *Annie's Song*; *Yesterday*, etc. (CBS)

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323493. Mormon Tabernacle Choir—Gloria! Vivaldi: *Gloria*; Fauré: *Sanctus*, etc. (Digital—CBS Masterworks)

311720. Luciano Pavarotti Premieres Verdi Arias—"Lost" gems from *I Vespri Siciliani*, etc. (Columbia)

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324772. Kiri Te Kanawa—Songs of the Auvergne (by Canteloube), English Chamber Orch. (Digital—London)

320887. Kiri Te Kanawa—Verdi and Puccini Arias. Pritchard, London Phil. (Digital—CBS Masterworks)

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with Social Security, replace a greater portion of the worker's final salary than does CSRS—based on identical salaries and thirty years of service.

Third, he said that the typical retirement age in industry is sixty-three or sixty-four, but that in civil service it is fifty-five. The General Accounting Office studied federal retirement records for the past ten years and found that the average age at retirement from civil service has been 61.1. A Johnson and Higgins poll of Fortune 500 companies found the average age at retirement to be 61.8.

Fallows endorses Senator Hollings's plea for a freeze on federal pensions (annuities). For the record, federal spending on civil-service retirement has already been reduced by \$5.3 billion since March of 1976, and the delay of the cost-of-living adjustment from May to December will add another \$1.5 billion to the sum. Meantime, according to Senator Howard Metzenbaum, large corporations enjoy a \$295 billion tax subsidy each year.

L. J. ANDOLSEK
President, National Association
of Retired Federal Employees
Washington, D.C.

James Fallows replies:

There are fairer and more accurate ways of stating the retirement issue than those Mr. Andolsek has chosen. To take his four points in order:

My article said that civil-service retirement "now costs roughly \$22 billion a year." "Now" refers to fiscal year 1984; Mr. Andolsek's figure of \$20.3 billion is for fiscal year 1983, which is not "now" but "last year." More important, Mr. Andolsek's attempt to compare employees' contributions with employees' benefits, and thereby to imply that the system is covering its own costs, is preposterous. In exchange for the pension contributions they make in any given year, civil servants (like other workers) receive a claim to future pension benefits. Those future claims—not this year's payments—are what should be compared with this year's contributions. If the "present value" of future benefits is equal to the present value of contributions, then the system is actuarially sound. ("Present value" is an accounting concept that allows for the interest that the contributions could theoretically earn in the years before the employee begins drawing benefits.) The future claims against civil-service retirement are so much larger than the scheduled contributions that, according to the Office of Personnel Management, the system has unfunded liabilities of roughly \$500 billion.

Mr. Andolsek's implied argument that retirees' \$2.5 billion in income taxes should be counted against their pension costs is even less defensible. By this reasoning, the expense of sustaining the military, paying interest on the national debt, supporting farm prices, running the federal government, and underwriting Social Security, Medicare, and—yes—civil-service pensions should fall on everyone except federal retirees.

Mr. Andolsek says that private pensions plus Social Security are more generous than civil-service pensions without it. He neglects to mention that some 80 percent of federal retirees eventually qualify for Social Security benefits as well. (This is because many of them retire early and then go back to work in jobs covered by Social Security.) Nor does he point out that federal pensions are fully indexed against inflation, whereas virtually no private pensions are.

There is a trick of definition concealed in Mr. Andolsek's third point. Federal retirement law says that a worker may receive a pension at age fifty-five with thirty years of service, or at sixty with twenty years, or at sixty-two with five years. Most of the retirees fall into two blocs: those who have made a career in federal service and are eligible at age fifty-five, and those who have worked more briefly for the government and must wait until sixty-two. Of the careerists, who make up slightly more than a third of all federal retirees (excluding those who retire with disabilities) and who receive the largest pensions, the great majority retire at fifty-five. But the others, who are not eligible until sixty-two, bring the average retirement age up.

Although Mr. Andolsek does not say so, the "reductions" in federal pensions are merely small decreases in a very high rate of increase. In 1960 the system cost \$805 million; in 1970, \$2.7 billion; in 1980, \$14.5 billion; and in 1985 it is expected to cost \$23.6 billion.

Why do Mr. Andolsek and others argue as they do? I think they resist all criticism of their system for the same reason that many politicians resist any comments about the inequities of Social Security. The federal retirement system is a very uneven thing. Some of its pensioners, like many on Social Security, receive a mere pittance. In the name of defending those needy pensioners Mr. Andolsek and others are forced to deny and distort fiscal reality. A more reasonable approach would be to limit full cost-of-living adjustments to the first \$10,000 or \$12,000 of a retiree's annual pension, as the National Committee on Public Employee Pension Systems has recommended. This would protect the poorest retirees while reducing the wind-fall that others receive.

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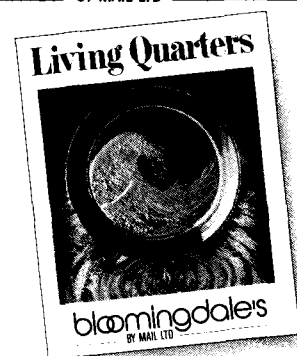
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REPORTS & COMMENT

NOTES COMMA

THE COMMA, WHICH seems to cup the sense of the preceding phrase and hold it out to us, timidly and respectfully, is one of our greatest breakthroughs. The civilizing influence of this punctuation aid derives partly from its odd shape, the shape of mosquito larvae and sea horses: close inspection reveals the implied high culture of its asymmetrical tapering swerve, so distinctly an advance over the more rustic period. Rationally, one might expect the functions of these two elements of punctuation to be reversed: The comma a baffle to the progress of the eye; the period, a mere dot, easily overlooked. The comma a fallen branch partially impeding a stream; the period, meanwhile, a single cold pebble. But the functions of the two are not reversed, I think, because the graceful curving motion necessary to the creation of the comma, that flip of the pen, is similar to the motions we use in writing the prose that surrounds it, while the period is an alien jab, tacking the sentence onto the paper.

The comma is like the expressive dips of the hands we employ when making a point in friendly conversation; the period is a tap of a judge's gavel. The comma is accommodating, deferential, clement; the period is Apollonian and preoccupied. As a general rule, the fewer commas you use, the more of a tyrant you would be if placed in a position of power. It is instructive to read political theorists in this light.

—Nicholson Baker

Nicholson Baker has published short stories in The Atlantic and The New Yorker.



1884

MOST OF THE fuss about 1984 has focused on the gap between the future that George Orwell imagined some forty years ago and the future that has arrived. A different perspective opens if we take a larger step back.

In 1884 the population of the United States stood at 55 million, well over ten times the population a century earlier but less than one quarter the population today. New York led American cities, with 1.8 million people, followed by Philadelphia with 850,000 and Chicago with 500,000. Atlanta had not yet reached 50,000, while Dallas and Los Angeles had barely passed 10,000.

Remarkable buildings had begun to rise in some cities. Otis Brothers & Company had not yet installed the first electric elevator, but hydraulic lifts were common. The New York skyline was dominated by the 284-foot spire of Trin-

ity Church and the 230-foot headquarters of the Western Union Company. In Chicago work had begun on William Le Baron Jenney's ten-story Home Insurance Building—the first iron-skeleton skyscraper.

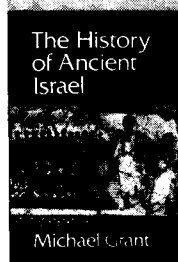
The streets of the great cities stank of horse manure. Private bathrooms were rare, but indoor plumbing had begun to replace the pump that had previously lifted water to the kitchen sink. Still unknown or undeveloped for commercial use, however, were flush-valve toilets, cast-iron radiators, and cast-iron enameled bathtubs—and the electrical marvels that have revolutionized domestic life in the twentieth century: washing machines and dryers, refrigerators, dishwashers, garbage disposers, and air-conditioners.

One marvel—Thomas Edison's electric light—had already arrived. In 1882 Edison had opened a power station that initially provided electricity for 400 lights serving eighty-five customers in lower Manhattan. By 1884 more than a

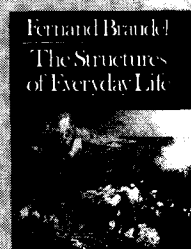
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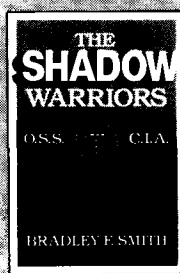
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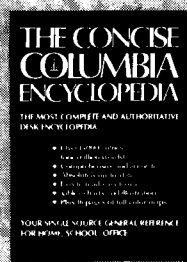
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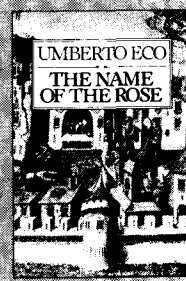
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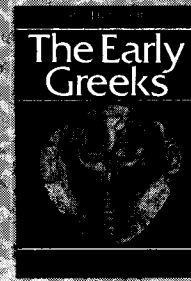
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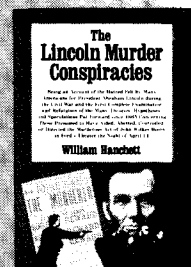
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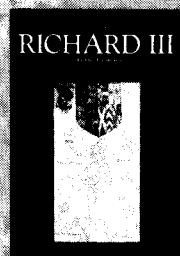
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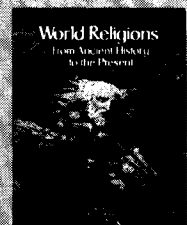
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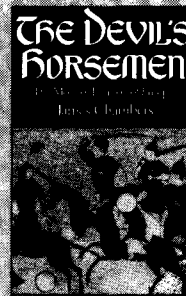
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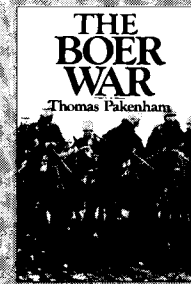
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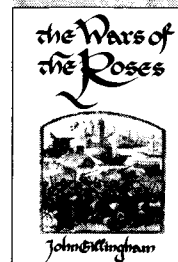
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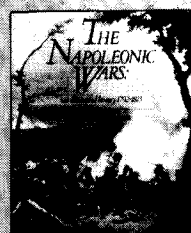
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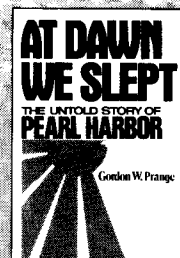
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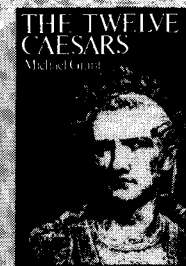
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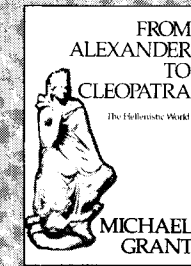
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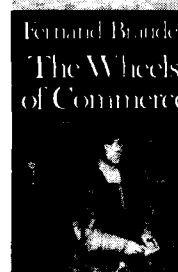
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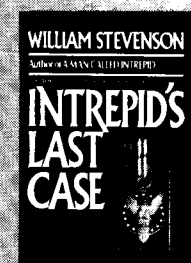
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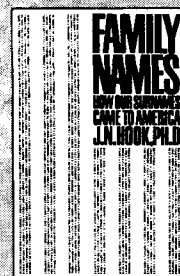
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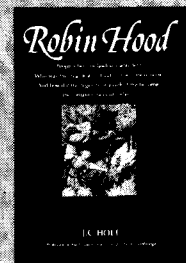
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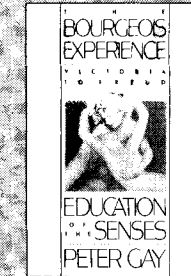
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hundred central electric stations had begun operation, but another two decades would go by before Michael Owens introduced a machine that made possible the mass production of light bulbs. Owens also pioneered the mass production of glass bottles, and thus set the stage for the age of bottled soft drinks.

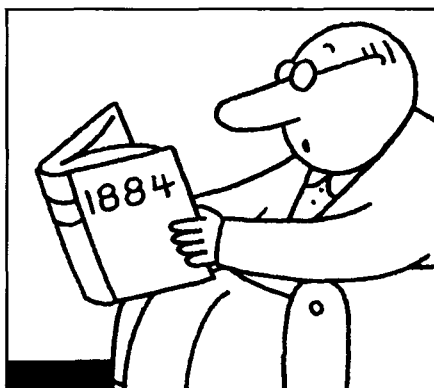
Edison's light was rivaled by another wonder—a machine that transmitted human speech over metal wires. By 1884 approximately 350,000 telephones had been installed in the United States—one for every 150 inhabitants. The number rose to 1.5 million by 1900, 28 million by the end of the Second World War, and somewhere between 160 and 175 million by 1982.

Long-distance telephone service between New York and Boston began in 1884, as did service between San Francisco and Sacramento. One could not yet place a call from one coast to the other or from either coast to Chicago. In situations that required quick communication, businessmen sent telegrams. Lovers in separate cities wrote letters.

To imagine an average business office of 1884 you must begin by imagining an office where work was not interrupted by telephone calls. A secretary, probably male, prepared correspondence by hand or struggled gallantly to extract a readable page from one of the newfangled typewriting contraptions. Managers did their jobs without dictation equipment or pocket calculators. A copier was a clerk with neat handwriting. Lewis Waterman had not yet perfected the fountain pen. William Burroughs had not yet invented the modern adding machine. No one had even conceived of a machine that could perform a million computations in a millisecond.

At home in the evening Americans could not flip on their television sets, their radios, or their stereo systems. They could not relax in theaters beneath screens that projected gigantic images of other human beings in motion. If a husband and wife wanted to hear music, they had to attend a concert or make music themselves. If they wanted to hear human speech, they had to converse.

Boxers still fought with bare knuckles in 1884. Walter George, of Great Britain, had reduced the record for the mile run to 4:18.4, approximately a second slower than the current record for women. In the first modern Olympics, in 1896, Spiridon Loues, of Greece, would win the marathon in 2 hours, 59 minutes—



50 minutes off Alberto Salazar's winning time in the 1982 New York Marathon, and 32 minutes slower than Grete Waitz's winning time for women in the same race.

No one worried about automobile fumes in 1884, no one worried about totalitarianism, and no one worried about nuclear war. A few people worried about the condition of the poor in cities, about corruption in government, and about the wealth, power, and questionable morals of a handful of men whom later generations would call the robber barons. Others worried about the rise of Darwinism, the decline of religious conviction, and the general unruliness of life in a democracy.

No one fretted about the size of the government, but the federal surplus caused great concern. Revenues exceeded expenditures every year from 1875 through 1893. To avoid withdrawing large sums from circulation, the Treasury was compelled to retire the public debt at an unprecedented rate. This is one trend we have managed to reverse: total federal expenditures grew from \$244 million in 1884 to \$728 billion in 1982, and the public debt grew from \$1.62 billion to \$1.14 trillion.

The world of 1884 seemed less dangerous than ours. Though balloonists had practiced aerial reconnaissance during the Civil War, no one had ever dropped a bomb from an airplane. Europeans worried about Prussian militarism, but Americans lived in proud isolation. An army of 26,000 men guarded our shores. A navy half that size patrolled the waters. Total federal expenditures for defense were \$56.7 million. Ninety-eight years later we preserved our sense of security at a cost of \$500 million a day, and more than two million people served in our regular armed forces, plus 800,000 in our reserves.

In the United States in 1884 there were 211 lynchings, mostly of white

males. Seventeen out of every hundred Americans over the age of ten could not read or write, in contrast to one out of a hundred today. The labor force included more than one million children under the age of fifteen. Institutions of higher education granted fifty-four doctorates in 1880, three of them to women. Nearly two million women worked, but none voted in national elections.

Physicians were beginning to understand aseptic techniques, but surgeons did not yet wear rubber gloves or surgical masks. In the summer and fall of 1884 cholera swept through France and Italy, killing nearly 15,000 people. No vaccines were available to protect against measles, flu, typhoid, tetanus, diphtheria, yellow fever, or polio. Doctors had no anti-tuberculosis drugs, no sulfa drugs to use against bloodstream infections, no antibiotics. No insulin for diabetics. No cortisone or steroids. No knowledge about vitamins or vitamin deficiencies. No psychoanalysis or psychotherapy. No tranquilizers. Medicine could recommend no reliable contraception other than abstinence. Coronary-bypass surgery was unknown, of course, as were neurosurgery, laser-assisted ophthalmologic surgery, cancer chemotherapy, radiation therapy, and diagnostic x-rays.

Diseases that we rarely think about took an enormous toll. The big killers were pneumonia and consumption. Diarrheal diseases ranked fourth, just behind heart disease. Life expectancy at birth (74 years in 1979) was approximately 43 years in 1884, while the rate of infant mortality (13 per thousand live births in 1979) was 160 per thousand, and the rate of maternal deaths in childbirth (9.6 per 100,000 live births in 1979) was well over 600 per 100,000 live births.

Though we live longer and longer, we do not live long enough to understand our world. As the pace of change quickens, the present becomes our prison, and we cling to it ever more desperately. We can peer a little forward and a little back, but we see less and less, and everything we see looks strange. Perhaps one day we will give up foresight and hindsight altogether. That year, whenever it comes, will be "1984."

—Peter Baida

Peter Baida is the director of development administration at Memorial Sloan-Kettering Cancer Center. He is writing a history of American business.



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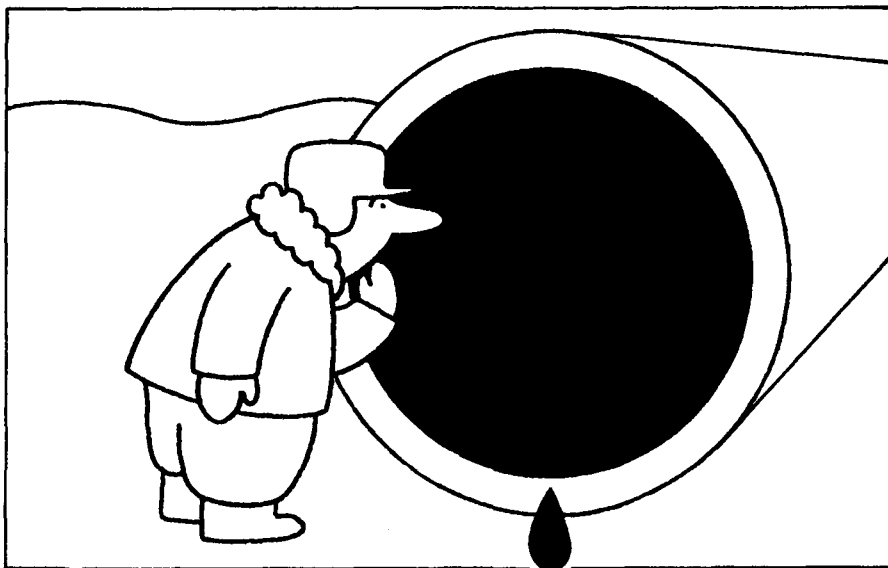
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IT IS TEMPTING to overlook the people of Alaska: they are so few, and their state is so vast. Everyone has heard that Alaska is big, but it really *is* big, and its natural features tend to dwarf anything that men have done. Even the trans-Alaska pipeline, that prodigy of large-scale engineering, has left a barely visible mark upon the landscape. After comparing the pipeline, as it appears from the air, to a thread across a golf course, one environmentalist told me that it was a good thing so few people had seen the territory the pipeline would traverse, back during the debates about its construction. The numbing emptiness, he said, would have made most people incapable of taking the need for environmental precautions seriously.

In their daily lives many Alaskans reinforce the impression that what matters most about their society is its natural setting. Much of local politics still turns on the "subsistence" issue—what share of the wild fish and fowl should be reserved for those who eat what they kill. Fairbanks, which with 28,000 people is the state's second-largest city, sits in the Alaskan interior on a patch of permafrost that sank like a tile when the earth's great crustal plates ground past each other. In this basin, sheltered from wind, dense,

gelid winter air collects; in January, Fairbanks enjoys slightly under four hours of sunlight a day and temperatures of 50° below zero. The difference between 20° and 50° below zero, I was told in Fairbanks during a recent visit, is that at 50° below you have to drive more carefully, because a tire can shatter if it hits a pothole.

But at the moment the real drama of Alaska does not concern its landscape, or even its weather. The state, bigger than most nations, now seems to be rapidly recapitulating some other nation's economic history. Is that other nation Nigeria?

Alaska's economic saga is a long chronicle of booms and busts. Russian trappers came for sea-otter fur, American prospectors came for gold, Japanese businessmen came for timber—and all of them left, once they had killed, dug, or cut the most profitable part of the resource. The latest boom, of course, is based on oil, and it too is nearing its end.

In the early 1960s the state government invited oil companies to bid for exploration rights on Alaska's North Slope, the bare, permanently frozen plain, home to musk-oxen and caribou, that reaches from the foot of the Brooks Range northward a hundred miles to the Arctic Ocean. The leases for the year 1965 brought in a paltry \$6 million. Three years later, at Prudhoe Bay, the Atlantic Richfield Company (ARCO) discovered the largest oil field in North America. By the early 1980s, when oil was flowing at full capacity through the trans-Alaska pipeline, ARCO and its sister companies were pumping \$6 million worth of oil every fourteen hours. In 1976, while the pipeline was still under production, Alaska's petroleum output

was worth about a third of a billion dollars. Five years later it was worth nearly ten times that much.

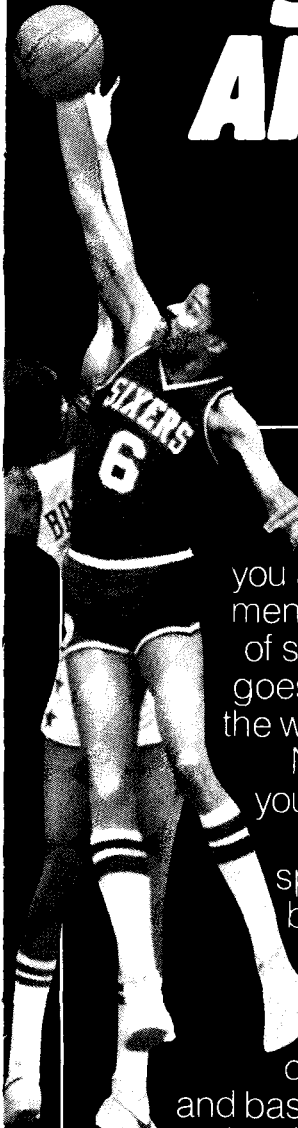
Of these new riches Alaskans have received at least their fair share. One barrel of each eight lifted from Prudhoe Bay is assigned to the state, as a royalty payment. In addition, the state imposes corporate income taxes, mineral-severance taxes, and various other measures designed to keep the wealth at home. From 1972 to 1982 Alaska's revenues, nearly all from oil, increased from \$48.4 million to \$3.6 billion. Of every dollar the state collects for its "general fund," 90 cents comes from oil.

Suddenly rich, Alaska was better equipped to meet its longest-standing internal challenge: the division of spoils between the growing number of white Alaskans and the aboriginal population of Eskimos, Indians, and others, collectively referred to as "Natives." In 1971 Congress passed the Alaska Native Claims Settlement Act, one of the most complicated pieces of legislation in the nation's history. The act extinguished the Natives' ancestral and often overlapping claims to Alaskan land, including certain portions intended for pipeline construction. In return, the 80,000 Natives received from the federal government a settlement of \$1 billion, and permanent title to about one ninth of the state's territory—44 million acres of land.

In itself, such a settlement constituted a dramatic departure from Indian relations as practiced in the rest of the United States (which Alaskans habitually refer to as "Outside"). The philosophy that accompanied it represented perhaps a greater change. In place of the socialist paternalism that had long guided the Bureau of Indian Affairs, corporate capitalism was to be brought immediately to Alaska's Natives. Their territory and resources were assigned to a variety of new "Native corporations," in which the Natives living at the time of the Settlement Act would be the only shareholders. A class of extremely urbane, Outside-educated Natives assumed leadership of the largest corporations and began investing their people's money in hotels, banks, fisheries, and oil. Even though their managerial mode of authority was at odds with the traditional hierarchy of the tribal village, some of the corporations pledged themselves to serve as bulwarks of the imperiled Native culture.

The Native politicians helped direct some of the state's oil wealth toward the

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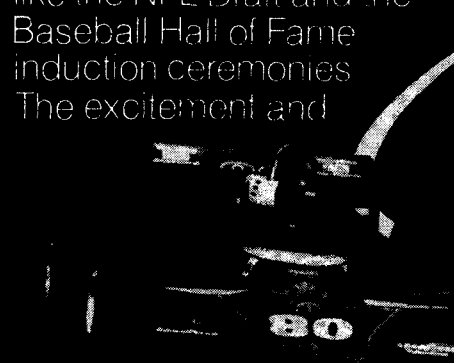
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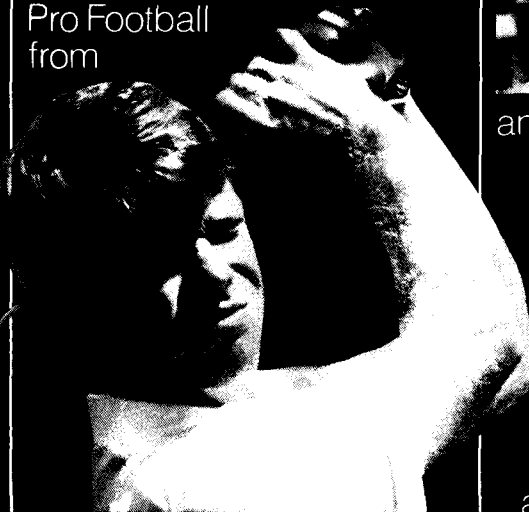


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remote bush villages where most Natives still live. The “bush caucus,” whose influence in Alaska is comparable to that of ethnic blocs in the eastern United States, pushed for new schools, community centers, and roads. Prefabricated school buildings were barged up from Seattle during the ice-free months and unloaded on islands and at coastal villages. Teachers were recruited, at the highest salaries in the nation (an average of \$37,200), to bring literacy, math, and science to villages that might contain six or eight students. Snowmobiles (called “snow machines”) and motorized “tricycles” with nubby all-terrain tires began to replace dog teams in the bush.

The rest of the state also experienced a capital-spending boom. New housing developments were built with government-subsidized loans. Ambitious hydroelectric projects were launched around the state. Using future oil revenues as security, some communities and the state government threw themselves onto the bond market. The North Slope Borough, the local government with jurisdiction over Prudhoe Bay, contracted long-term indebtedness of \$1.2 billion, or \$150,000 for each of its 8,000 mainly Native citizens. Alaska's population, which had risen during the pipeline-construction boom of the early 1970s, began falling after 1977, when the pipeline was finished and the welders and truck drivers went back to Texas to look for work. But in 1981 the population exploded again. There had been 302,000 Alaskans in 1970, and 402,000 ten years later, after the pipeline boom had leveled off. But last year the state's population topped half a million, and it is now said to be growing by 10 percent a year.

Yet on their arrival these new Alaskans find a state that sees the bottom of its money barrel. Vast as it is, the Prudhoe Bay field is not limitless. Almost a third of its proven reserves are already gone, and its production will begin to fall within five years. More important, the crash in the world oil market means that each barrel taken from Prudhoe Bay leaves less money in Alaska's hands than Alaska had anticipated. In 1981, when oil prices were high, the Department of Revenue estimated that in the next fifteen years the state could count on \$99 billion in oil revenues. One year later it had reduced its estimate to \$35 billion. For ten years Alaska's hardest puzzle was figuring out the best way to invest its wealth. Now its fiscal officers can point to budget deficits within three years.

WILL THIS MAKE Alaska our own little Nigeria, desperately broke so soon after it seemed to swim in wealth? Many Alaskans answer in the negative, and they have two arguments on their side.

One is that Anchorage, traditionally a trading center that drew on a vast, primitive hinterland, has finally reached the critical size at which it can generate its own demand and support its own enterprises. Instead of merely importing finished equipment and exporting oil, gold, and fish, Anchorage now has small factories producing some of the manufacturing supplies and consumer goods that once came from Seattle and Los Angeles. Of the new nongovernment jobs created in Alaska since the beginning of the pipeline boom, in 1973, only about a quarter were directly tied to oil or other extractive industries. The rest were in finance, services, tourism, manufacturing, and other fields typical of a diversified economy. If these other engines of economic life keep Alaska afloat while the good ship *Oil* is sinking, they will support Jane Jacobs's theory that import-substitution is the basis of economic growth.

The second argument concerns a less tangible asset: the immigrant vitality of Alaskans. As a focus for immigration, Alaska has long been a cross between a land of golden opportunities and a last outpost for those on the lam. (Last March, in Anchorage, I walked through a Native art gallery with the curator, who described the provenance of several dozen pieces of antique walrus ivory worth \$1,000 or more apiece. A few weeks later I saw a newspaper clipping saying that he had vanished—along with much of the collection.) Some of its immigrants are running away from the boss, the sheriff, or the alimony collector. But many others are ambitious young people who recognize that they can take charge more quickly here than anywhere else in the United States. Alaska's population is the youngest in the country; much of the politics, communications, and business activity in Anchorage seems to be dominated by people in their twenties and early thirties. Perhaps they will find a way to see their state through the coming hard times.

But consider what they and other Alaskans are up against. They have advertised themselves as what they originally must have been: ferocious individualists, bent on fending for themselves and scornful of socialist coddling. Yet

their economy has grown more dependent on the generous hand of the state than the most Democratic wards of Chicago ever were.

This is partly unavoidable. The government, in its various federal and state guises, owns nearly all the land in Alaska. Apart from the Natives' territories, less than one percent of Alaska's land is in private hands. Because it takes a lot of people to administer the National Parks, supervise the salmon hatcheries, and run the military bases, the government plays the employer's role to roughly the same degree in Alaska as it does in Washington, D.C.

Perhaps it was also unavoidable that the state would enact many public benefits—entitlements, in Outside parlance—without knowing how to pay for them once the oil money was gone. The state now spends about four times as much money per Alaskan (in real terms) as it did ten years ago—but it collects much less money from any source except the oil wells. In 1980 it abolished the personal income tax, and it has no sales tax. (When you offer a dollar bill for a 95-cent item, you suffer momentary confusion upon getting a nickel in change.) Alaskans, in their affluence, have created an elaborate network of entitlements unrelated to need. Students in Alaska are eligible for low-interest loans to finance college or graduate education—and half of the total is forgiven if they return to the state for five years. Elderly "pioneers" with twenty-five years' residence in Alaska can receive subsidized housing in the state's Pioneer Homes. Even though there is no income tax, there are two leftover tax credits—in effect, full rebates of up to \$100 for political contributions and \$230 for child-care expenses. And then there is the "dividend."

In an attempt to smooth the way to the post-oil future, the state's voters in 1976 approved the creation of a "Permanent Fund." One quarter of all mineral royalties, plus related income, go straight into the fund. (By 1983, \$3.7 billion had been paid in, while another \$14 billion of oil revenues had been spent.) The principal of the fund was carefully hoarded for the future, but what of the interest it earned? Jay Hammond, a bush pilot and swashbuckling figure who was governor throughout the oil-boom period, promoted the idea of the "dividend"—a direct payout of the profits to all citizens of the state.

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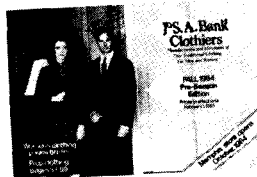
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largest dividends would have gone to those who had lived longest in Alaska. The federal courts threw out that provision, saying it was discriminatory, and dividends were awarded to anyone who had been in the state for six months. The first dividend, paid in 1982 and reflecting several years' accumulated earnings, was \$1,000 per person. Later payments were to represent half the annual income of the fund; the other half was to be reinvested to protect the principal against inflation.

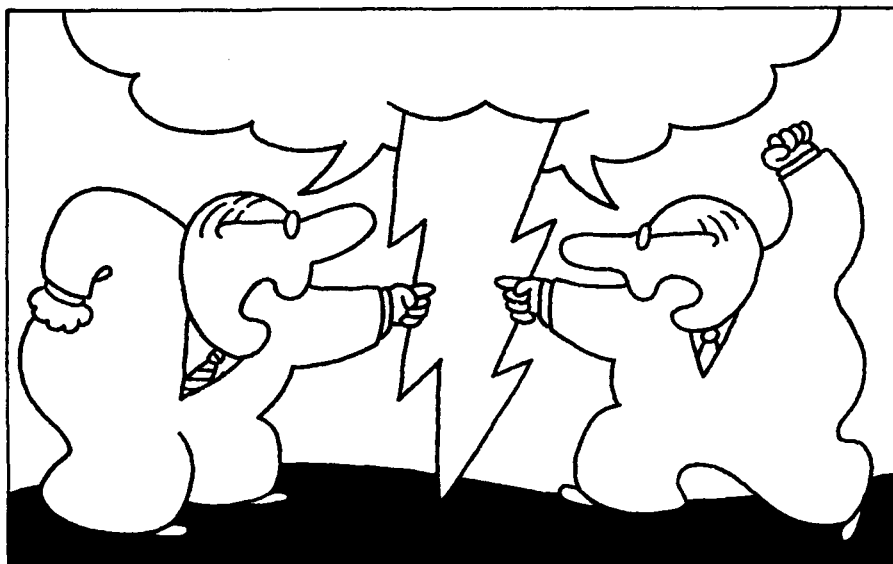
The idea behind the dividend was to give every Alaskan a stake in the sharp-eyed management of the Permanent Fund. If your annual check reflected the market performance of the fund, you would presumably be more skeptical of its being invested in low-interest urban-

development loans—and more interested in blue-chip stocks or mineral investments. It seemed like a dream come true for J. Peter Grace and everyone else who has ever said that government should be run like a business.

The dream will last just as long as the oil does; then Alaskans will have to figure out how to pay their way. In the U.S. Congress strong men quake at the task of reducing benefits we can no longer afford. Alaska will soon face that task. If its people, so inventive and optimistic, accomplish it, they will have something to teach not merely the other oil baronies but also their fellow citizens Outside.

—James Fallows

James Fallows is the Washington editor of The Atlantic.



WASHINGTON A BIPARTISAN FOREIGN POLICY

An argument that the Constitution invites "struggle for the privilege of directing American foreign policy"

"IF WE ARE to have a sustainable foreign policy," President Reagan said late this past spring, "the Congress must support the practical details of policy, not just the general goals." Thus began an offensive aimed at blaming Congress for the tragic debacle in Lebanon and at shifting responsibility onto Congress in case the United States

should be faced with the choice of either sending troops to Central America or losing it to Marxist revolution.

By asserting that Congress has a historical obligation not to second-guess the President when national security is at stake, the President was appealing to a commonplace of American folklore—that "politics [stops] at the water's edge." "We must restore bipartisan consensus," Reagan said; "Republicans and Democrats standing united in patriotism and speaking with one voice. . . ."

This notion—that national security has been bipartisan—is a distorted reading of American history. It is based on the myth that if only we could be cured of our Vietnam syndrome, we would return to the traditional American practice of supporting the President when the nation is involved in foreign conflicts. However, since the United States began

intervening abroad, foreign policy has aroused passions and divided the nation as much as any domestic controversy.

When, for example, we liberated the Philippines and Cuba during the Spanish-American War, there was an explosive national debate over American imperialism. On one side were Republicans like President McKinley and Senator Henry Cabot Lodge, on the other reformers like William Graham Sumner and Mark Twain. The winning of new territory and the getting of new markets is "part of the Almighty's infinite plan," said one Republican senator. "Expansion and imperialism," replied an opponent, "are at war with the best traditions, principles, and interests of the American people."

Two decades later, as the First World War ended, the country was locked in a passionate debate over whether the United States should join the League of Nations. President Wilson made entrance into the League his final crusade. He wanted a "community of power," a utopian organization in which all nations would work together to prevent aggression. Theodore Roosevelt was more hard-nosed. He would have preferred a much different kind of world organization, one based on a "balance of power," a selected group of allies to police the world. This was an age that "[rejected] the standards of national selfishness," Wilson said. "The cult of internationalism," Roosevelt replied, "is . . . a doctrine of fatal sterility. I . . . keenly distrust the man who cares for other nations as much as for his own." Eventually the Senate rejected U.S. participation in the League.

By the late 1930s another great political clash had arisen, over whether the United States should get involved in what was to become the Second World War. One of America's great foreign-policy debates erupted over the Neutrality Acts of 1935, 1936, and 1937. On one side were ardent advocates of our keeping out of any conflict, led by Republican Senator Robert Taft. On the other was President Franklin Roosevelt. Taft said that U.S. security could be secured "by establishing our defense line based on the Atlantic and Pacific Oceans." His eye on the gathering storm of war abroad, FDR countered, "Let no one imagine that America will escape, that . . . this Western Hemisphere will not be attacked."

Those who long for a bipartisan consensus on foreign policy are quick to

mention Republican Senator Arthur Vandenberg, a stalwart of the Senate Foreign Relations Committee in the 1940s and 1950s. A leading isolationist before the Second World War, he became a supporter of America's overseas involvement during and after it. Vandenberg's "conversion" is often interpreted as symbolizing the end of inter-party debate on the fundamental goals of U.S. foreign policy, and it is true that from 1941 to 1952 there was more agreement than before between the major parties on foreign affairs. During this time, for example, the United Nations charter, the Marshall Plan, and the North Atlantic Treaty Organization sailed through Congress. But other controversies soon emerged.

In the early Cold War years, a time nostalgically recalled as one of foreign-policy consensus, America's overseas strategy was the subject of intense political debate. From 1950 to 1953 the China-Formosa-Korea tangle pitted President Truman against former President Hoover and other prominent Republicans. The arguments were basic: whether to contain communism in Asia by means of a limited war in Korea or by risking an all-out conflict with China. Truman, Dean Acheson, and other mainstream Democrats argued strongly for restraint. The Republicans were of two minds: one faction, led by Hoover, wanted to withdraw from Asia altogether; the other, led by Senator Joseph McCarthy, accused the Democrats of being soft on communism.

At about the same time, the short-lived postwar agreement on defending Europe was coming under attack by Congress. Facing a Democratic Administration's proposal for an Army buildup, more than a hundred Republican congressmen and senators, led by Senator Taft, balked. They objected not only to the deployment of U.S. troops in Europe but also to the broader defense goals this implied. Taft called for a defense policy limited to protecting the Western Hemisphere, Britain, the Philippines, and Formosa. Hoover, his ally, proposed that U.S. defense abroad rely mainly on air and sea power, rather than ground troops. Truman saw in these policies a return to isolationism and congressional obstructionism, and his Administration fought back bitterly.

The political conflicts over the Vietnam War need little elaboration, and since that war foreign policy has occasioned no end of tension between Con-

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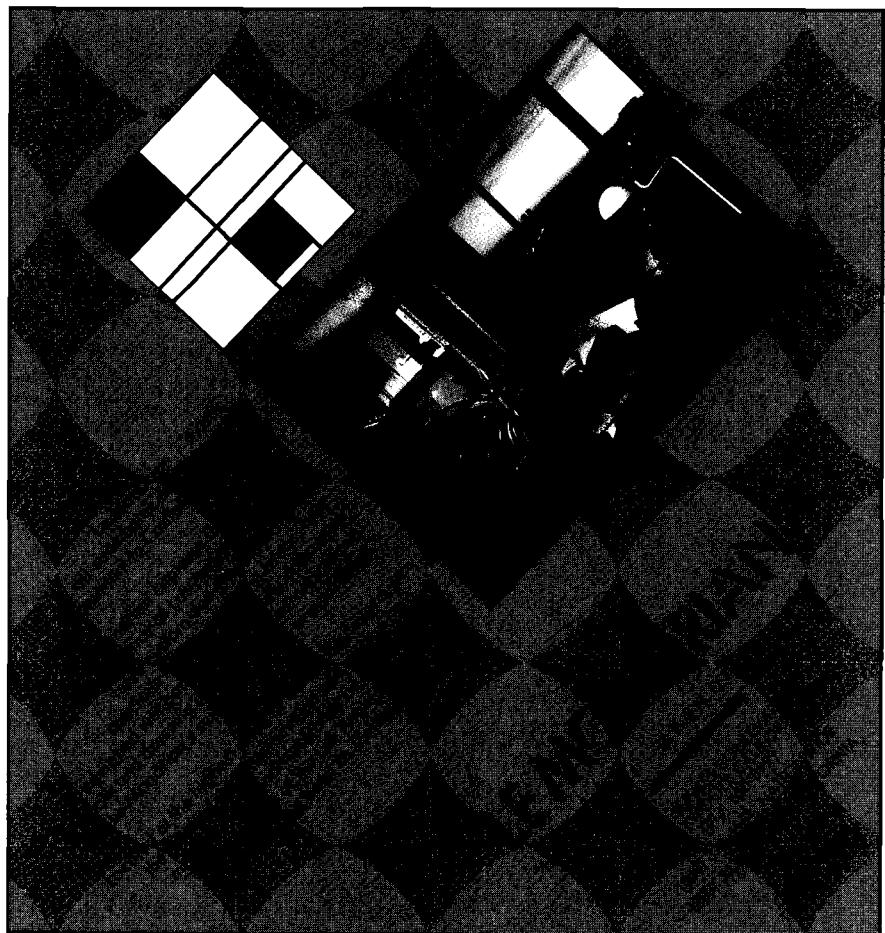
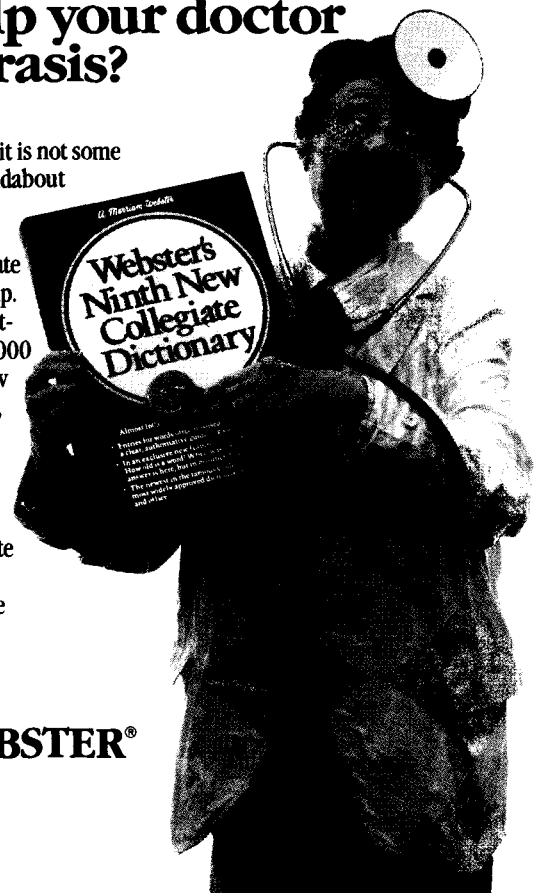
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gress and the President. In the 1970s the legislature redirected the foreign-aid program, brought to the fore human-rights concerns, and tied American trade with Communist countries to their emigration policies. It imposed restrictions on overseas sales of arms and nuclear equipment, prohibited U.S. intervention in Angola, and intervened in the negotiation of the Panama Canal treaties. It refused to act on major arms-control agreements, and set up a continuing process for overseeing U.S. intelligence activities.

AT THE ROOT of every major controversy in foreign affairs has been the question of who—Congress or the President—is empowered to decide on issues of war and peace. The answer is rarely clear-cut, because the Founding Fathers tried to curtail the traditional prerogatives of the kings they had known with the decentralization of power that they wanted in the New World. Alexander Hamilton, to take one example, warned of the danger of entrusting “interests of so delicate and momentous a kind, as those which concern [our] intercourse with the rest of the world, to the sole disposal of a magistrate created and circumstanced as would be a President of the United States.” But he also recognized that the limits of presidential power couldn’t be defined too exactly. As the historian Edward S. Corwin has said, from the beginning the Constitution was “an invitation to struggle for the privilege of directing American foreign policy.”

The President’s rhetoric about congressional obstruction notwithstanding, Capitol Hill has been trying only to exert the powers that it was originally given in the Constitution and that it has exercised many times before. These include the power to declare war, to license limited hostilities, to demand accountability and information from the executive, and to appropriate funds for overseas activities.

Moreover, compared with his predecessors, President Reagan has not had a particularly difficult time with Congress. Through the spring of 1984—the point at which Reagan began his attack upon congressional meddling in earnest—Congress had given the Administration almost everything that it wanted. It approved the stationing of troops in Lebanon, despite the absence of any clear strategic goals, and even as the Defense Department questioned whether the in-

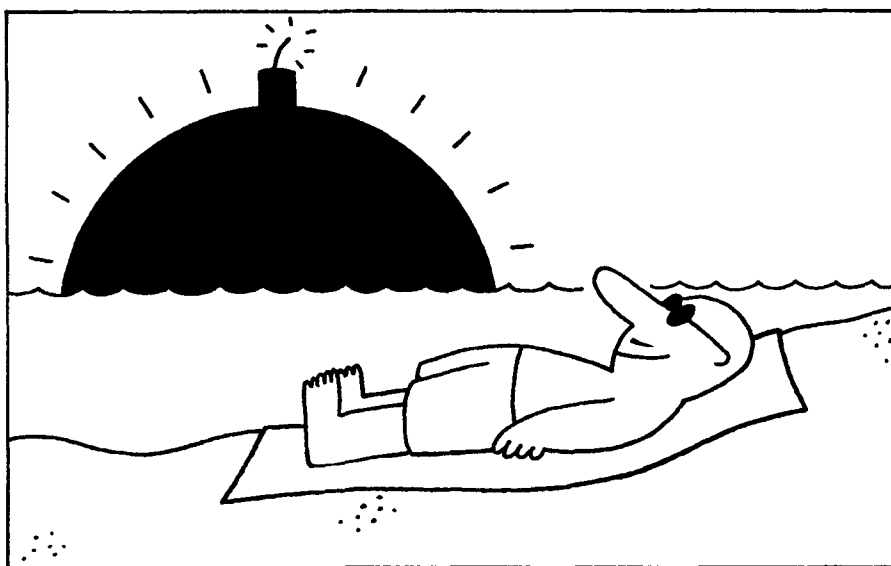
volvement made any sense. And there was hardly a peep from Congress when the United States invaded Grenada.

Even in Central America—the area where the President feels most hamstrung—congressional concerns over appropriations for aid have done no more than slow up the United States’ participation and force the President continually to justify his actions. But Capitol Hill has not seriously challenged the Administration’s basic objective of providing military aid to stop a communist takeover of El Salvador. Congress has tacitly allowed the Administration to increase U.S. troop levels from thirty to some 1,700 soldiers in Honduras, to build airstrips, and to direct the CIA to

finance elections in El Salvador and to destabilize the regime in Nicaragua. There will, of course, be arguments over the effectiveness of the President’s strategy, and more representatives and senators will be asking whether we are headed for a war, or at least for the militarization of all of Central America. But, mindful of the agonizing dilemmas ahead, who—except perhaps President Reagan—would have Congress roll over and play dead?

—Jeffrey E. Garten

Jeffrey E. Garten was on the State Department’s policy-planning staff in the Ford and Carter administrations, and writes frequently about public-policy issues.



BRAZIL

A NEW GIANT IN THE ARMS INDUSTRY

Exporting arms has proven the key to trade surpluses and growing political power

WHEN ISRAELI JETS destroyed Iraq’s first nuclear-power plant, in 1981, few people realized, and the Brazilian government at first denied, that the primary fuel for Iraq’s nuclear program was uranium dioxide that had been shipped from Brazil to Baghdad. Brazil’s involvement in the Middle East, however, is in fact extensive.

In several recent years Brazil has exported more foodstuffs than any nation

save the United States. Also, it has substantial reserves of thorium, fuel for the impending generation of breeder reactors. And a single Brazilian company, Engesa, manufactures more than half the world’s wheeled armored vehicles.

Brazil annually exports billions of dollars’ worth of technology and weapons systems. In 1981 its engineers won a competition to construct a \$280 million highway in Iraq, perhaps because of their performance earlier in building a \$1.2 billion high-speed railway to link Baghdad with Akashat, near the Jordanian and Syrian borders. Brazilians are constructing a huge \$600 million hydroelectric dam at Palmar, Uruguay; another, even larger one at Guri, Venezuela; and a highway across Mauritania. They are also totally redesigning the Algerian railroad network. Still more construction and technical projects have been contracted with El Salvador, Bolivia, Ecuador, Guatemala, Honduras, Para-

guay, Surinam, Nigeria, Libya, Qatar, Malaysia, and other developing nations. This year more than 12,000 Brazilian civilian technical experts are abroad on such projects.

The Brazilian production and sale of weapons and weapons systems has increased at a truly phenomenal rate. Brazil exported no arms until 1975, but in 1982, according to *The International Defense Review*, it was fifth in the world (after the United States, the USSR, France, and West Germany) as a purveyor of weapons. Brazil has sold some 2,000 armored vehicles to the People's Republic of China; a variety of military hardware to left-leaning regimes in Surinam and Guyana (in an ongoing attempt to displace Cuban influence there); infantry weapons to Greek Cypriot authorities (over strident Turkish protest); twenty-five Xingu trainer aircraft (manufactured by the Brazilian company Embraer) and \$280 million worth of armored cars to Libya; counterinsurgency vehicles to Colombia and Nigeria; military aircraft to the Sudan; military helicopters to Peru; turbojet trainers to the French air force; maritime patrol aircraft to Uruguay; river warships to Paraguay; and artillery rockets, 105mm cannon, anti-tank missiles, armored personnel carriers (APCs), light tanks, and armored cars to Iraq.

The Brazilian arms industry, 95 percent of whose production is exported (in contrast, less than 15 percent of the United States' goes abroad), is diversified and sophisticated, and is making itself felt in the Third World. Employing some 110,000 people in at least 350 companies, about half of which are state-run, the industry is loosely controlled and coordinated by Imbel, a research-and-planning agency created by government decree in 1975 and run by the Army Ministry. Imbel—now directed by José Luiz Whitaker, who also runs Engesa—has two principal international functions. It seeks out Western armaments firms that produce hardware it considers suitable for Brazilian export and entices them to build factories in Brazil or to license the production of their hardware in that country. Investments, transfers of technology, and the creation of new export items result, for companies like FN (a Belgian company that produces rifles), Oerlikon (Swiss, anti-aircraft guns), Marconi (British, torpedoes), and Aerospatiale (French, helicopters). Imbel is also responsible for soliciting and negotiating foreign arms sales. Its frenetic front

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men can be found wining and dining government officials from Khartoum to Kuala Lumpur.

About 80 percent of Brazil's weapons industry is based in and around the city of São José dos Campos, not far from São Paulo. So intensive is the industrial activity there that the city and its environs consumed as much electricity in 1983 as did Brazil's sixteen most rural states. Many factories run three shifts and still cannot keep up with foreign orders.

IN 1979 Stephanie G. Neuman and Robert E. Harkavy, in their *Arms Transfers in the Modern World*, estimated that by the 1980s Brazil might be exporting \$500 million in arms annually. That figure was at least equaled in 1980, and 1983 arms sales abroad have been reported at \$2.5 billion. Individual contracts of \$150 million and more are becoming common, at least forty nations are importing Brazilian military goods, and Brasilia's forecast of \$3 billion in military sales for 1984 is perhaps on the conservative side.

Arms exports began after the founding of Imbel, and were spurred on by two circumstances. One was that huge amounts of cash were being drained from Brazil to pay for imported oil, the price of which was spiraling upward (the oil crisis gave rise to an "export or die" campaign in Brasilia); the other was a severe chill in relations with the United States. Because of disagreements with Washington over a host of matters, including human rights and transfers of nuclear technology, Brasilia in 1977 abrogated its twenty-five-year-old military-assistance treaty with the United States. Having thus declared its independence from the United States and its technology, Brasilia had good reason to encourage domestic weapons manufacture and export.

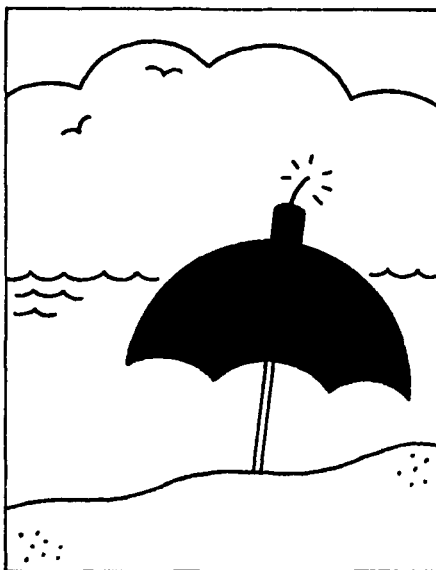
The chilliness between Washington and Brasilia abated somewhat after President Reagan replaced Carter and as Brazil moved steadily closer to democracy after twenty years of sometimes oppressive military rule.

In 1982 Presidents Reagan and João Baptista Figueiredo exchanged state visits. On February 6, 1984, in Brazil, Secretary of State George Shultz initialed a memorandum of understanding on military cooperation with Brazil. The agreement permitted U.S. defense firms to set up shop in Brazil and transfer some advanced technology. One serious hitch, however, is that the U.S. government claims the right to determine to which

nations U.S. weapons and licensed parts can or cannot be sold. Aside from offending Brazil's pride in its independence, what Brasilia sees as a blacklist contains the names of two of Brasilia's biggest customers: Iraq and Libya. Brazil would, for example, very much like to use U.S. technology to upgrade its Engesa armored vehicles, but its largest markets for these vehicles are nations on the blacklist. How this and similar problems can be resolved remains to be seen.

The meteoric rise of Brazil's arms industry and its entry into the international arms bazaar offer the country some important benefits:

1) Brazil is becoming self-sufficient with respect to weapons it needs to guarantee its security. And the foreign business leads to long production runs, cut-



ting unit costs and spreading research and development costs, which in turn means internal savings on hardware for the Brazilian armed forces.

2) The high technology used in arms manufacture is spilling over into civilian manufacture. Conversely, because of the great profits to be made, government incentives, and a decrease in sales of consumer goods due to inflation and austerity measures imposed by the International Monetary Fund, many civilian companies with plants in Brazil, such as Singer, General Electric, Vigorelli, and Honeywell, are moving into arms production.

3) Brazilian influence in the developing world has expanded dramatically.

4) Brazil has had trade surpluses for the past three years (\$6.5 billion in 1983). This has mollified the bankers to whom Brazil owes so many billions.

These benefits are likely to continue, and thus they must be taken into account by policy planners in the United States and other countries that deal with Brazil.

Despite twenty years of military rule Brazil is not by any stretch of the imagination a highly militarized country. In fact, in this respect it is a veritable model for emerging nations. Since 1964 its military manpower has increased by only 25 percent, whereas the nation's population has increased by approximately 70 percent. In 1978 the military's share of the national budget was smaller than the shares for the ministries of Education and Culture, Welfare and Social Security, and Transport. In 1980 Brazil spent a mere \$17 per capita on its military (whose duties and expenses include a great number of public-works projects), which was only .9 percent of its GNP (down from 3.2 percent in 1965). In contrast, Argentina averaged \$94 and 2.4 percent, and Peru \$46 and 5.7 percent. And in 1982 Cuba was superior in both manpower and equipment. According to a 1980 report by the U.S. Arms Control and Disarmament Agency, Brazil ranks with Fiji, Malta, and Barbados in GNP per capita and in percentage of GNP spent for arms.

Clearly, then, we are witnessing not the growth of a military power but the emergence of a technological and trading power. Whereas much of the new technology has been acquired by license from Western Europe, a growing proportion is indigenous, and nearly all of it is geared to the export market. Thus, although Brazil plans to export Type 209 submarines (licensed by Germany), AMX jet fighter/trainers (Italy), and computers for military use (the United States), it has already earned billions of dollars exporting weapons of Brazilian design and manufacture.

The most successful Brazilian export armaments are those with dual application: to conventional warfare and to counterinsurgency efforts. Engesa's Urutú and Cascavel armored vehicles are slugging it out on the Iran-Iraq border as well as traveling trails in Morocco, Colombia, and Nigeria in search of rebels. Similarly, Embraer's Xingú turbojet trainers are used as such by the French air force but are also used effectively as flying weapons platforms by Honduras, Libya, and Togo.

Brazilian armaments are famous for their flexibility; they are all things to all men. Most are offered in very basic configurations, but with a wide range of op-

tions. For instance, the basic Urutú, an APC of Brazilian design, costs a mere \$225,000, less than a quarter of the price of a U.S. Bradley fighting vehicle, and its turrets can mount anything from 7.62mm machine guns to 40mm anti-aircraft guns to hefty 90mm cannon. It can also be fully air-conditioned and sealed against nuclear, biological, and chemical agents, or it can be totally amphibious. Such design flexibility is lacking in the more sophisticated products of Brazil's competitors.

Third World nations are attracted to Brazilian products also because of their simplicity. Brazilian submachine guns, light tanks, parachutable jeeps, and jet trainers are built to survive the indifferent maintenance so common in the underdeveloped world. They are simple, rugged machines that can take the worst climate and terrain, and maintenance at the hands of the most loutish recruit. Avibras, a company whose range of surface-to-air missiles and artillery rockets are lighting up the skies of the Middle East, produces what the *Christian Science Monitor* recently called "the most efficient conventional missiles available."

SIMPLICITY, FLEXIBILITY, reliability, low cost, and the fact that Brazil is independent of the superpower blocs bring the factories of São José dos Campos orders from Asia, Africa, the Middle East, and Latin America.

Of those regions, the Middle East has been the most affected by Brazil's arms sales (one third of Brazil's 1983 exports went to that region). Brasilia has sold hardware to Qatar, Algeria, Libya, Abu Dhabi, and others, and its weapons are used by both sides in the Persian Gulf war. Brazil's planning minister, Deltim Netto, with Imbel experts in tow, visited Iraq, Iran, and Saudi Arabia on the eve of the Persian Gulf war, offering attractive arms "packages." The visit paid off handsomely with contracts from Baghdad and Tehran. In 1980 Iraq spent \$280 million on Brazilian armored vehicles, artillery, and rockets. In 1981, as the war with Iran broke out, Iraq's volume increased to \$600 million; the following year, and last year, the volume increased again, to approximately \$1 billion. Iraq keeps buying, because the price is right, because the weapons work under harsh circumstances, and because no strings are attached.

Libya is another major customer for Brazilian weapons, and is a known conduit of these to Iran (as well as to other

nations, including Upper Volta, and to rebels in Chad). Libya's purchases include huge numbers of rockets, bombs, armored vehicles, military trucks, trainer/ground-support aircraft, and helicopters. Libya bought a hundred of Embraer's Tucano trainers from Brazil in 1982 alone—certainly not solely for the use of its own small air force.

The Persian Gulf war might well be difficult to maintain if Brasilia embargoed the contestants. This, however, is unlikely, because Brazil needs the money. Brazilian weapons are winning rave reviews—even if Brazilian anti-tank missiles often streak out from Iranian lines to smash through Brazilian-made Iraqi APCs. Brazil is in the regional arms race to stay, much to the distress of Israel (with whose armaments Brazil's compete elsewhere). According to Neuman and Harkavy, "Israeli experts consider that Brazilian participation in the Middle East arms race will become an additional concern for Israel" and (according to one of their sources) will "exert influence on the armament balance of the region." Brazil's role is indeed likely to increase, especially with the advent, in 1984 and 1985, of Embraer's AMX attack jet, Avibras's runway-cratering bombs, and a whole new line of Brazilian missiles, including an Exocet-like ship-killer and the Piranha air-to-air missile.

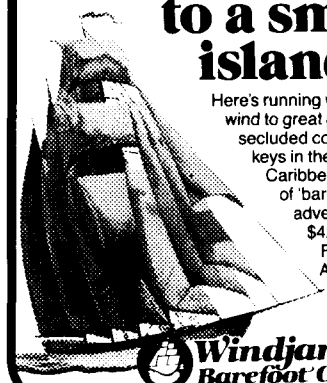
Outside the Middle East, Brazil has been and is a formidable competitor among arms purveyors, including the United States. The French bought Brazilian turbojet trainers in preference to U.S. models; Ecuador, Colombia, Bolivia, and Honduras are opting increasingly for armaments made by the "colossus of the South" rather than that of the North; nations of Africa, diverse though they might be politically, buy Brazilian; and so do nations as unlike as Morocco, Paraguay, and Britain. Even Brazil's continental rival, Argentina, less likely than ever to buy from Britain's friend the United States, has become a substantial consumer of Brazilian armaments since the Falklands/Malvinas crisis.

Brazil's influence is a fact. That it will expand, especially in the world's less stable regions, seems all but certain. We are learning to live with nuclear proliferation. We will have to learn to live with arms-manufacture proliferation as well.

—John Hoyt Williams

John Hoyt Williams is a professor of history at Indiana State University.

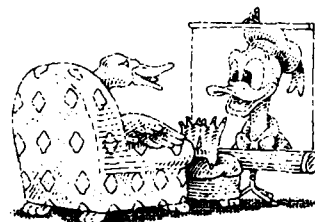
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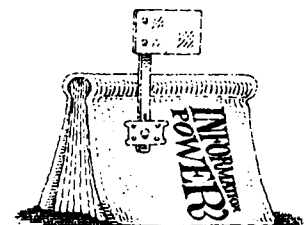
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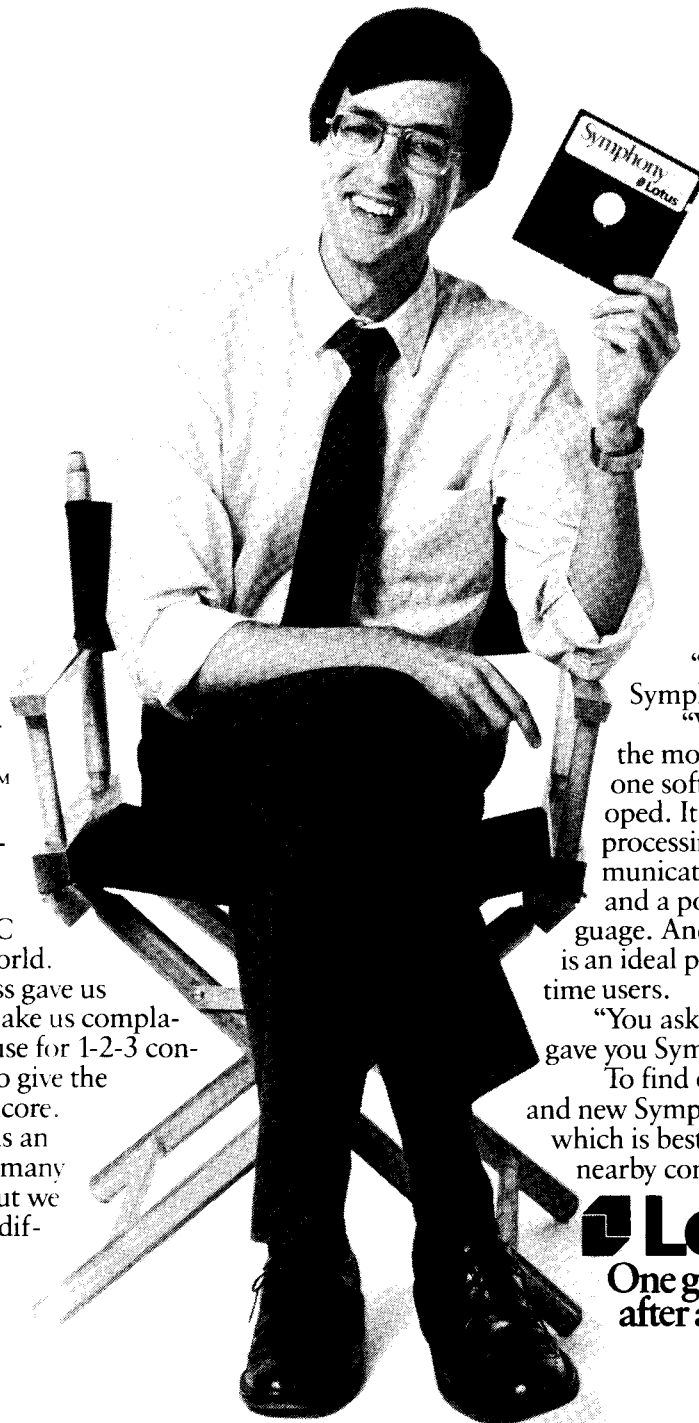
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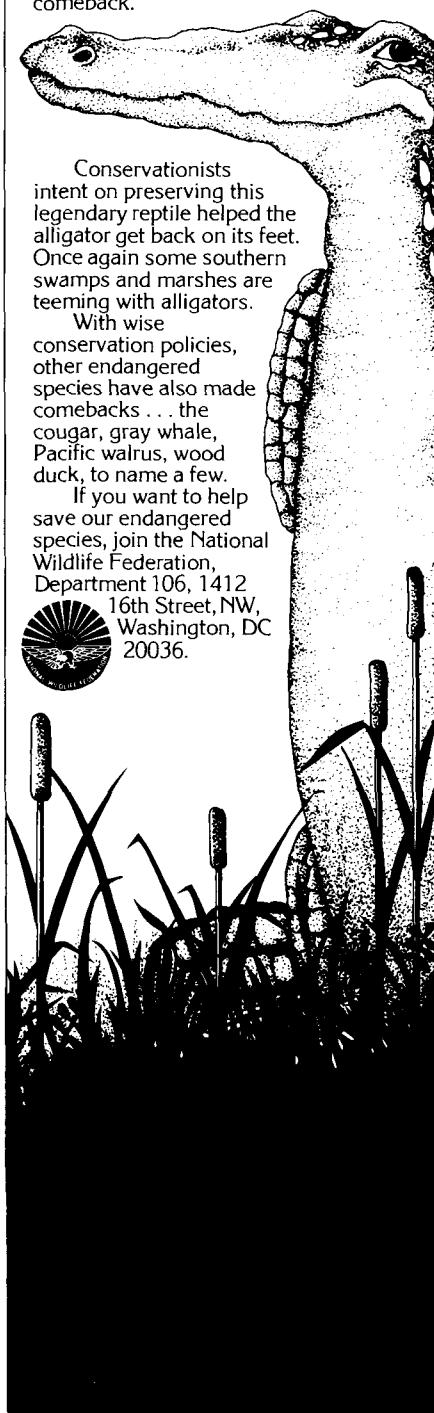
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MUSEUMS, NO

BY ROBERT M. STROZIER

A FRIEND ONCE SAID to me, "The trouble with a museum is that, well, it's a *museum*." I know exactly what he was driving at. A longtime New Yorker, I go to museums fairly often, but I've been rethinking the whole thing lately. I don't know about you, but I become instantly aimless and kind of floppy upon entering a museum. With good intentions I set out to do, say, Greek friezes, but then I make a wrong turn and suddenly find myself in a room filled with Flemish tapestries or early New Brunswick furniture or little Aztec tools. Searching blindly for the original path, I stray yet more: wander into the Triptychs Wing, perhaps never to return, or end up standing in line for the All the Chinese Vases exhibition.

In New York a person lives with a constant dark presence, and it's called the Metropolitan Museum of Art. It stares down at you from its august height, saying: ENTER NOW AND DON'T RETURN TO YOUR OTHER LIFE. Cradled in its vast bosom are some *three million* items of art, each more important than the last. Even if you finally come to terms with the Met, you won't have begun to make a dent in the museum world.

This museum thing affects everyone, not just city dwellers. Jot down the first ten words that come to mind when I say: THE LOUVRE. I bet they all have to do with inadequacy and loneliness and desperation and physical exhaustion. Let's start with the last. People talk about "museumitis," and it's a real affliction, all right. Confronted by anything hanging on a wall, the body starts to sag. I think it has to do with a tension between the two parts of the trunk: the lower half says "Move on," the upper, "Stand and absorb the beauty."

All other art forms—literature, con-

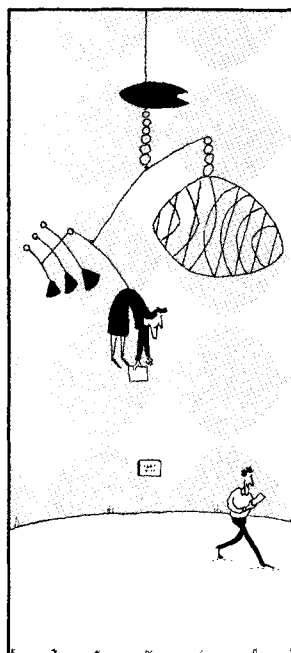
certs, operas, movies—allow us to sit down. Not a museum, no way. You're lucky to find an occasional hard, backless bench, its tiny surface occupied by about fifteen people, their behinds fighting for a grip. Usually I just plunge on, but at the Met's Vatican Collections exhibition last year I got really tuckered out about halfway through. For ten minutes I staked out the one bench in the vicinity and then darted in when a corner spot became vacant, just beating out

a heavysset woman in her fifties. In retrospect I can see how truly undignified it was to fight for a seat in the New Directions in Papal Patronage Room.

Something else happens to me when I enter a museum: my body starts whining and asking for something to eat. I crave something that I can stuff into my mouth and relate to at the most elemental of levels. Sometimes I take a bag of M&M's along and pop them as I go, even as I spend more and more time in front of paintings titled *Still Life of Bowl of Fruit* and *Study of Asparagus*. Museums also immediately make me want to

go to the bathroom, which is unfortunate, because, huge as these buildings are, they have only two bathrooms. All the great museums of the world have only two bathrooms. And two water fountains. And these are usually roped off.

IT'S A TRIBUTE to New Yorkers that they go to museum shows, but the downside of this commitment is that they do go—lots of them. Every morning thousands of them wake up, stretch, and say, "Let's go block some views of art today." Part of me actually likes the crowds: I'm reminded that we're all in this together. And it certainly beats being the only one there. Surely there is no greater loneliness in the world than being by yourself in a room filled with gigantic paintings by the masters. The



Robert M. Strozier is the executive editor of *Success* magazine.

masters were not a fun, lighthearted group, and the gloomier and more anguished they got, the bigger they painted. Enormous, unforgiving saints, dark, brooding cardinals, and great winged things stare down at you, reproaching you for being such an ignoramus.

It's even worse if there's a guard around. Bad enough that he thinks you may steal something, but you also know that he's got your number. Under the assumption that I'm being watched, I usually scrutinize each masterpiece in turn for a long time, cock my head left and right, murmur appreciatively, form a church steeple with the fingers to help frame the different elements, jot things down in a notebook if I remembered to bring one, pretend to be smitten by the sublimity of it all.

Anyway, crowds. I visited the Met's Manet exhibition a while ago, and it was packed. I kept expecting a hostess to come by and say, "Okay, let's all mingle, everybody." The painting that most struck my fancy was *Boating*, but I had to take a slow boat myself to get there. I kept poling nearer, catching glimpses now and then, through the jungle of napes, of what appeared to be blue sky, but then my sextant went on the blink or something, because when I finally hit a clearing the sky turned out to be a cloud cover of blank wall just left of a vent. At another point I got turned completely around and arrived at a painting only to find myself facing the opposite direction.

Museums also sorely lack dramatic guideposts. No curtain goes up; you never get to applaud; nothing has a clear-cut beginning, middle, and end. When reading a book, you come to the last page, savor the conclusion, snap the volume shut, and get on with your life. Art won't allow you that pleasure: everything is kind of mushy and undefined and paralyzing. When you do finally take those first uncertain, shuffling steps on to the next room, the slighted *objet d'art* pushes off and follows you home, perches on the headboard of your bed, and says bad things about you all night in a kind of mournful hiss.

To make sure you have someone to turn to at all times, it is best to go to a museum with a friend, but the choice must be made with great care. Museums have been known to destroy friendships and dissolve marriages in a single afternoon. At the Manet show I heard a woman say to her husband, very irritably, "I am *not* just wandering around, I am

looking at the paintings." Maybe states should even require that couples go to a museum together before they get married. In any case, proceed with caution in choosing a companion. You certainly don't want someone who moves faster than you do, because then you'll both be out on the street in ten minutes, nursing terrible anxieties. Nor, God knows, do you want someone who pokes along at an impossibly conscientious pace. I once went to an exhibition with a woman friend who examined each *oeuvre* at length, read all the inscriptions at least four times, lingered over every single item, even if it was only a doodle on a sketch pad, and recited sections of Colingwood's *Principles of Art* under her breath, caressing the words with her tongue. This woman was having a love affair with a museum.

I like to move out fast, hit four or five rooms, and then circle back and rejoin my partner for a while before taking off again. This must be very unnerving for the person, but it's all I know. You certainly don't want to *be* with someone the whole time. That requires, among other things, that you make conversation and offer trenchant views. The less said about art the better, I submit. If the aesthete in you tries to get out, *hurt* it and make it want to go back in.

Now and then you do have to say something, of course; otherwise your companion will think you're a total dodo. My approach is a feigned deep, silent communion with the work, punctuated by flip and offhand remarks: "Un-believable."/"I wouldn't want to be alone with him in a dark alley."/"These boys [the Popes] sure knew how to live, didn't they?" The image I hope to project is of someone so sophisticated that he can afford to be cute, though some might argue that I'm living beyond my means. But the real risk one runs is of simply being *wrong*. A friend of mine who attended a Calder exhibition overheard a woman providing instruction to four companions, who hung intently on every word. "The sculpture can be divided into two categories," she explained with great solemnity. "Stables, which are free-floating, and mobiles, which are stationary."

I see my time is nearly up, but I keep hearing that museums are great places to meet singles. Maybe that is the way to go. On second thought, I think I'll pass. This has got to represent a nadir of some kind: getting all dolled up to go hang out in the Etruscan Room. □

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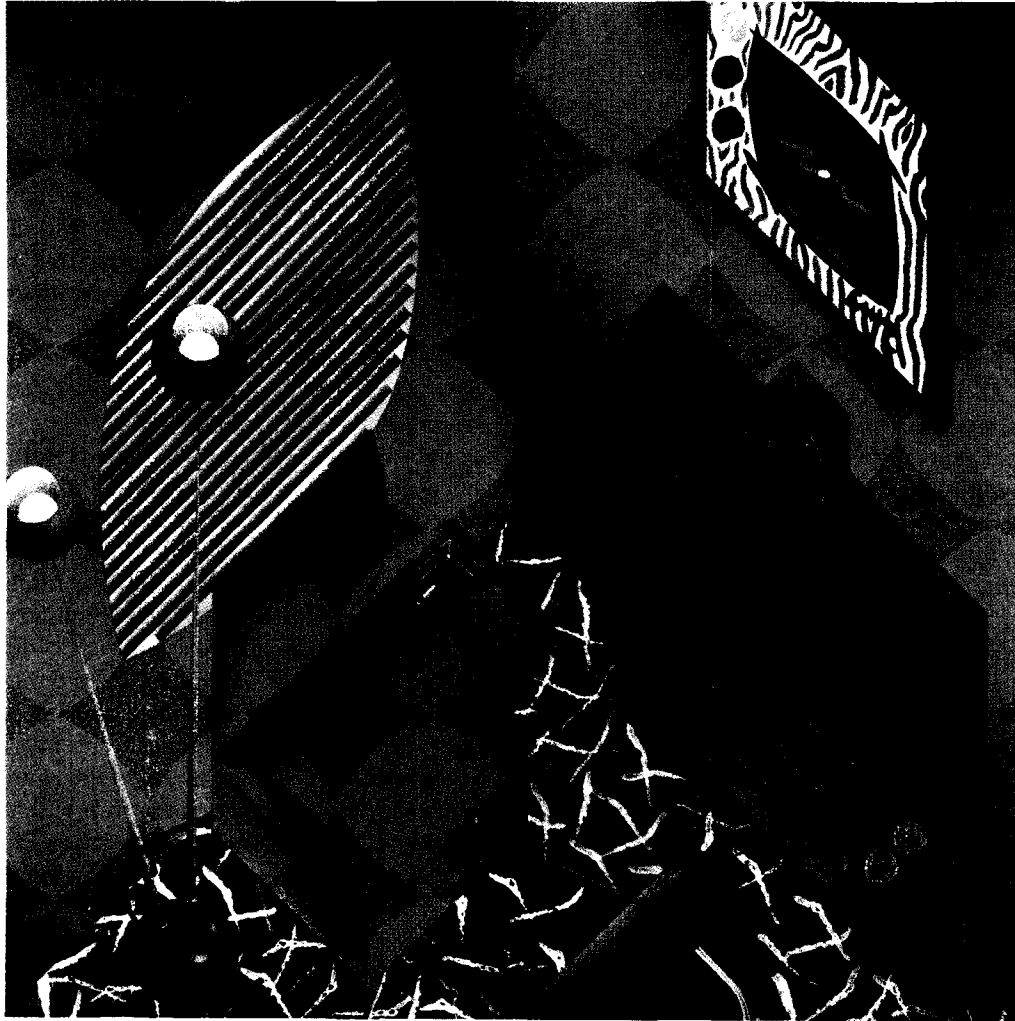
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The "most effective purveyor of language, image, and narrative in American culture" is still more reviled and laughed at than seriously examined

UNDERSTANDING TELEVISION

BY DAVID MARC



IN ONE OF THE FEW FAMOUS SPEECHES GIVEN ON THE subject of television, Federal Communications Commission chairman Newton N. Minow shocked the 1961 convention of the National Association of Broadcasters by summarily categorizing the membership's handiwork as "a vast wasteland." The degree to which Minow's metaphor has been accepted is outstripped only by the appeal of television itself. Americans look askance at television, but look at it nonetheless. Owners of thousand-dollar sets think nothing of calling them "idiot boxes." The home stereo system, regardless of what plays on it, is by comparison holy. Even as millions of dollars change hands daily on the assumption that 98 percent of American homes are

equipped with sets and that these sets play an average of more than six and a half hours each day, a well-pronounced distaste for TV has become a prerequisite for claims of intellectual and even of ethical legitimacy. "Value-free" social scientists, perhaps less concerned with these matters than others are, have rushed to fill the critical gap left by status-conscious literati. Denying the mysteries of teller, tale, and told, they have reduced the significance of this American storytelling medium to clinical studies of the effects of stimuli on the millions, producing volumes of data that in turn justify each season's network schedules. Jerry Mander, a disillusioned advertising executive, his fortune presumably socked away, has even written a book titled

Four Arguments for the Elimination of Television. Hans Magnus Enzensberger anticipated such criticism as early as 1962, when he wrote,

The process is irreversible. Therefore, all criticism of the mind industry which is abolitionist in its essence is inept and beside the point, since the idea of arresting and liquidating industrialization itself (which such criticism implies) is suicidal. There is a macabre irony to any such proposal, for it is indeed no longer a technical problem for our civilization to abolish itself.

Though Mander, the abolitionist critic, dutifully listed Enzensberger's *The Consciousness Industry* in his bibliography, his zealous piety—the piety of the convert—could not be restrained. Television viewers (who else would read such a book?) scooped up copies at \$6.95 each (paperback). As Enzensberger pointed out, everyone works for the consciousness industry.

Despite the efforts of a few television historians and critics, like Erik Barnouw and Horace Newcomb, the fact is that the most effective purveyor of language, image, and narrative in American culture has failed to become a subject of lively humanistic discourse. It is laughed at, reviled, feared, and generally treated as persona non grata by university humanities departments and the “serious” journals they patronize. Whether this is the cause or merely a symptom of the precipitous decline of the influence of the humanities during recent years is difficult to say. In either case, it is unfortunate that the scholars and teachers of *The Waste Land* have found “the vast wasteland” unworthy of their attention. Edward Shils spoke for many literary critics when he chastised those who know better but who still give their attention to works of mass culture, for indulging in “a continuation of childish pleasures.” Forgoing a defense of childish pleasures, I cannot imagine an attitude more destructive to the future of both humanistic inquiry and television. If the imagination is to play an epistemological role in a scientific age, it cannot be restricted to “safe” media. Shils teased pop-culture critics for trying to be “folksy”; unfortunately, it is literature that is in danger of becoming a precious antique.

AS THE TRANSCONTINENTAL INDUSTRIAL PLANT built since the Civil War was furiously at work meeting the new production quotas encouraged by modern advertising techniques, President Calvin Coolidge observed that “the business of America is business.” Since that time television has become the art of business. The intensive specialization of skills called for by collaborative production technologies has forced most Americans into the marketplace to consume an exceptional range of

goods and services. “Do-it-yourself” is itself something to buy. Necessities and trifles blur to indistinction. Everything is for sale to everybody. As James M. Cain wrote, the “whole goddamn country lives selling hot dogs to each other.” Choice, however, is greatly restricted. Mass-marketing theory has formalized taste into a multiple-choice question. Like the menu at McDonald's and the suits on the racks, the choices on the dial—and, thus far, the cable converter—are limited and guided. Yet even if the material in each TV show single-mindedly aims at increasing consumption of its sponsors' products, the medium leaves behind a body of dreams that is, to a large extent, the culture we live in. If, as Enzensberger claimed, we are stuck with television and nothing short of nuclear Armageddon will deliver us, then there is little choice but increased consciousness of how television is shaping our environment. Scripts are written. Sets, costumes, and camera angles are imagined and designed. Performances are rendered. No drama, not even melodrama, can be born of a void. Myths are recuperated, legends conjured. These acts are not yet carried out by computers, although network executives might prefer a system in which they were.

Beneath the reams of audience-research reports stockpiled during decades of agency billings is the living work of scores of TV-makers who accepted the marketable formats, found ways to satisfy both censors and the popular id, hawked the Alka-Seltzer beyond the limits of indigestion, and still managed to leave behind images that demand a place in collective memory. The life of this work in American culture is dependent upon public taste, not market research. A fantastic, wavy, glowing procession of images hovers over the American antennascape, filling the air and millions of screens and minds with endless reruns. To accept a long-term relationship with a television program is to allow a vision to enter one's life. That vision is peopled with characters who speak a familiar idiosyncratic language, dress to purpose, worship God, fall in love, show élan and naiveté, become neurotic and psychotic, revenge themselves, and take it easy. While individual episodes—their plots and climaxes—are rarely memorable (though often remembered), cosmologies cannot fail to be rich for those viewers who have shared so many hours in their construction. The salient impact of television comes not from “special events,” like the coverage of the Kennedy assassinations or of men on the moon playing golf, but from day-to-day exposure. Show and viewer may share the same living room for years before developing a relationship. If a show is a hit, if the Nielsen families go for it, it is likely to become a Monday-through-Friday “strip.” The weekly series in strip syndication is television's most potent oracle. Because of a sitcom's half-hour format, two or even three of its episodes may be aired in a day by local stations. Months become weeks, and years become months. Mary accelerates through hairdos and hem lengths; Phyllis and Rhoda disappear as Mary moves to her high-rise swinging-singles apartment. Mere plot suspense

David Marc, who teaches in the American Civilization program at Brown University, is the author of *Demographic Vistas*, a book about television which was published recently by the University of Pennsylvania Press.

or identification with characters yields to the subtler nuances of cohabitation. The threshold of expectation becomes fixed, as daily viewing becomes an established procedure or ritual. The ultimate suspension of disbelief occurs when the drama—the realm of heightened artifice—becomes normal.

The aim of television is to be normal. The industry is obsessed with the problem of norms, and this manifests itself in both process and product. Whole new logics, usually accepted under the general classification “demographics,” have been imagined, to create models that explain the perimeters of objectionability and attraction. A network sales executive would not dare ask hundreds of thousands of dollars for a prime-time ad on the basis of his high opinion of the show that surrounds it. The sponsor is paying for “heads” (that is, viewers). What guarantees, he demands, can be given for delivery? Personal assurances—opinions—are not enough. The network must show scientific evidence in the form of results of demographic experiments. Each pilot episode is prescreened for test audiences who then fill out multiple-choice questionnaires to describe their reactions. Data are processed by age, income, race, religion, or whatever cultural determinants the tester deems relevant. Thus the dull annual autumn dialogue of popular-television criticism:

Why the same old junk every year? ask the smug, ironic television critics after running down their witty lists of the season’s “winners and losers.”

We know nothing of junk, cry the “value-free” social scientists of the industry research factories. The people have voted with their number 2 pencils and black boxes. We are merely the board of elections in a modern cultural democracy.

But no one ever asked me what I thought, mumbles the viewer in a random burst from stupefaction.

Not to worry, the chart-and-graph crowd replies. We have taken a biopsy from the body politic, and as you would know if this were your job, if you’ve seen one cell—or 1,200—you’ve seen them all.

But is demography democracy?

Fortunately, TV is capable of inspiring at least as much cynicism as docility. The viewer who can transform that cynicism into critical energy can declare the war with television over and instead savor the oracular quality of the medium. As Roland Barthes, Jean-Luc Godard, and the French devotees of Jerry Lewis have realized for years, television is American Dada, Charles Dickens on LSD, the greatest parody of European culture since *The Dunciad*. Yahoos and Houyhnhnms battling it out nightly with sub-machine guns. Sex objects stored in a box. Art or not art? This is largely a lexicographical quibble for the culturally insecure. Interesting? Only the hopelessly genteel could find such a phantasmagoria flat. Yesterday’s trashy Hollywood movies have become recognized as the unheralded work of auteurs; they are screened at the ritziest art houses for connoisseurs of *le cinéma*. Shall we need the French once again to tell us what we have?

TELEVISION IS FUNNY

THOUGH NETWORK EXECUTIVES RESERVE PUBLIC pride for the achievements of their news divisions and their dramatic specials, comedy has always been an essential, even the dominant, ingredient of American commercial-television programming. As Gilbert Seldes wrote, in *The Public Arts*, “Comedy is the axis on which broadcasting revolves.” The little box, with its oblong screen egregiously set in a piece of overpriced wood-grained furniture or cheap industrial plastic, has provoked a share of titters in its own right from a viewing public that casually calls it the “boob tube.” Television is America’s jester. It has assumed the guise of an idiot while actually accruing power and authority behind the smoke screen of its self-degradation. The Fool, of course, gets a kind word from no one: “Knee-jerk liberalism,” cry the offended conservatives. “Corporate mass manipulation,” scream the resentful liberals. Neo-Comstockians are aghast, righteously indignant at the orgiastic decay of morality invading their split-level homes. The avant-garde strikes a pose of smug terror before the empty, sterile images. Like the abused jester in Edgar Allan Poe’s “Hop-Frog,” however, the moguls of Television Row make monkeys out of their tormentors. Profits are their only consolation; the show must go on.

In 1927 Philo T. Farnsworth, one of TV’s many inventors, presented a dollar sign on a television screen in the first demonstration of his television system. By the late 1940s baggy-pants vaudevillians, stand-up comedians, sketch comics, and game-show hosts had all become familiar video images. No television genre has ever been without what Robert Warshaw called “the euphoria [that] spreads over the culture like the broad smile of an idiot.” Police shows, family dramas, adventure series, and made-for-TV movies all rely heavily on humor to mitigate their bathos. Even the news is not immune, as evidenced by the spread of “happy-talk” formats in TV journalism in recent years. While the industry experiments with new ways to package humor, television’s most hilarious moments are often unintentional, or at least incidental. Reruns of ancient dramatic series display plot devices, dialogue, and camera techniques that are obviously dated. Styles materialize and vanish with astonishing speed. Series like *Dragnet*, *The Mod Squad*, and *Ironside* surrender their credibility as “serious” police mysteries after only a few years in syndication. They self-destruct into ridiculous stereotypes and clichés, betraying their slick production values and affording heights of comic ecstasy that dwarf their “original” intentions. This is an intense comedy of obsolescence that grows richer with each passing television season. Starsky and Hutch render Jack Webb’s Sergeant Joe Friday a messianic madman. *Hill Street Blues* returns the favor to *Starsky and Hutch*. The distinction between taking television on one’s own terms and taking it the way it presents itself is of critical importance. It is the difference between activity and passivity. It is what saves TV from becoming the ho-

mogenizing, monolithic, authoritarian tool that the doomsday critics claim it is. The self-proclaimed champions of "high art" who dismiss TV shows as barren imitations of the real article simply do not know how to watch. They are like freshmen thrust into survey courses and forced to read Fielding and Sterne; they lack both the background and the tough-skinned skepticism that can make the experience meaningful. In 1953 Dwight Macdonald was apparently not embarrassed to condemn all "mass culture" (including the new chief villain, TV) without offering any evidence that he had watched television. Not a single show was mentioned in his famous essay "A Theory of Mass Culture." Twenty-five years later it is possible to find English professors who will admit to watching *Masterpiece Theatre*. But American commercial shows? How could they possibly measure up to drama produced in Britain and tied in form and sensibility to the nineteenth-century novel? To this widespread English Department line there is an important reply: TV is culture. The more one watches, the more relationships develop among the shows and between the shows and the world. To rip the shows out of their context and judge them against the standards of other media and other cultural traditions is to ignore their American origins and misplace their identities.

ENTER THE PROSCENIUM

THE FORMS THAT CAME TO DOMINATE TELEVISION comedy—and therefore television—were video approximations of theater: the situation comedy (representational) and the variety show (presentational). The illusion of theater is a structural feature of both. It is created primarily by the implicit attendance of an audience that laughs and applauds at appropriate moments and thus assures the viewer that the telecast is originating behind the safe boundary of the proscenium. Normal responses are thus defined. The "audience" may be actual or an electronic sound effect, but this is a small matter. The consequence is the same: the jokes are underlined.

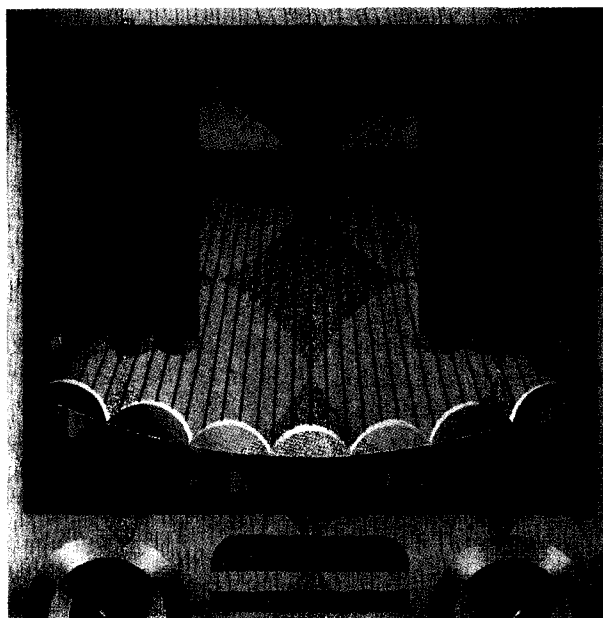
The situation comedy has proved to be the most durable of all commercial-television genres. Other types of programming that were staples of prime-time fare at various junctures in TV history (the western, the comedy-variety show, and the big-money quiz show among them) have seen their heyday and faded. The sitcom, however, has remained a ubiquitous feature of prime-time network schedules since the premiere of *Mary Kay and Johnny*, on DuMont, in 1947. The TV sitcom obviously derives from its radio predecessor. Radio hits like *The George Burns and Gracie Allen Show* and *Amos 'n' Andy* made the transition to television overnight. Then, as now, familiarity was a prized commodity in the industry. The sitcom bears a certain resemblance to the British comedy of manners, especially on account of its parlor setting. A more direct ancestor may be the serialized family-comedy adventures that were popular in nineteenth-century American newspapers. Perhaps because of the nature of its serial continuity,

the sitcom had no substantial presence in the movies. Though Andy Hardy and Ma and Pa Kettle films deal with sitcom themes, their length, lack of audience-response tracks, and relatively panoramic settings make them very different viewing experiences. Serial narratives in the movies were usually action-oriented. The Flash Gordon movies, for example, were constructed so that each episode built to a breathless, unfulfilled climax designed to bring the patrons back to the theater for the next Saturday's resolution. The lack of life-and-death action in the sitcom makes this technique irrelevant. Urgent continuity rarely exists between episodes. Instead, climaxes occur within episodes (though these are not satisfying in any traditional sense). In the movie serial (or in a modern television soap opera) the rescue of characters from torture, death, or even seemingly hopeless anxiety is used to call attention to serialization. The sitcom differs in that its central tensions—embarrassment and guilt—are almost always alleviated before the end of an episode. Each episode may appear to resemble a short, self-contained play; its rigid confinement to an electronic approximation of a proscenium-arch theater, complete with laughter and applause, emphasizes this link. Unlike a stage play, however, a single episode of a sitcom tends to be of dubious interest; it may not even be intelligible. The attraction of an episode is the strength of its contribution to the broader cosmology of the series. The claustrophobia of the miniature proscenium, especially for an audience that has grown casual toward Cinemascope, can be relieved only by the exquisiteness of its minutiae.

Trivia is the most salient form of sitcom appreciation, perhaps the richest form of appreciation that any television series can stimulate. Though television is at the center of American culture—it is the stage upon which our national drama/history is enacted—its texts are still not available upon demand. The audience must share reminiscences to conjure up the ever-fleeting text. Giving this exchange of details the format of a game, players try not so much to stump as to overpower one another with increasingly minute, banal bits of information that bring the emotional satisfaction of experience recovered through memory. The increased availability of reruns that cable service is bringing about can only serve to deepen and broaden this form of grass-roots TV appreciation. Plot resolutions, which so often come in the form of trite, didactic "morals" in the sitcom, are not very evocative. The lessons that Lucy Ricardo learned on vanity, economy, and female propriety are forgotten by both Lucy and the viewer. A description of Lucy's living-room furniture (or her new living-room furniture) is far more interesting. The climactic ethical pronouncements of Ward Cleaver recapture and explore the essence of *Leave It to Beaver* less successfully than a well-rendered impersonation of Eddie Haskell does. From about the time a viewer reaches puberty, a sitcom's plot is painfully predictable. After the tinkering of the first season or two, few new characters, settings, or situations can be expected. Why watch, if not to visit the sitcomosmos?

The sitcom dramatizes American culture: its subject is national styles, types, customs, issues, and language. Because sitcoms are and always have been under the censorship of corporate patronage, the genre has yielded a conservative body of drama that is diachronically retarded by the precautions of mass-marketing procedure. For example, *All in the Family* can appropriately be thought of as a sixties sitcom, though the show did not appear on television until 1971. CBS waited until some neat red, white, and blue ribbons could be tied around the turmoil of that extraordinarily self-conscious decade before presenting it as a comedy. When the dust cleared and the radical ideas that were being proposed during that era could be represented as stylistic changes, the sixties could be absorbed into a model of acceptability, which is a basic necessity of mass-marketing procedure. During the sixties, while network news programs were offering footage of Vietnam, student riots, civil-rights demonstrations, police riots, and militant revolutionaries advocating radical changes in the American status quo, the networks were airing such sitcoms as *The Andy Griffith Show*, *Petticoat Junction*, *Here's Lucy*, and *I Dream of Jeannie*. The political issues polarizing communities and families were almost completely avoided in a genre of representational comedy that had always focused on American family and community. Hippies would occasionally appear as guest characters on sitcoms, but they were universally portrayed as harmless buffoons possessing neither worthwhile ideas nor the power to act, which might make them dangerous. After radical sentiment crested and began to recede (and especially after the first steps were taken toward the repeal of universal male conscription, in late 1969), the challenge of incorporating changes into the sitcom model was finally met. The dialogue that took place in the Bunker home had been unthinkable during the American Celebration that had lingered so long on the sitcom. But if the sitcom was to retain its credibility as a chronicler and salesman of American family life, these new styles, types, customs, manners, issues, and linguistic constructions had to be added to its mimetic agenda.

The dynamics of this challenge can be explained in marketing terms. Five age categories are generally used in demographic analysis: (1) 2–11; (2) 12–17; (3) 18–34; (4) 35–55; (5) 55+. Prime-time programmers pay little attention to groups 1 and 5; viewing is so prevalent among the very young and the old that, as the joke goes on Madison Avenue, these groups will watch the test pattern. Prime-time



television programs are created primarily to assemble members of groups 3 and 4 for commercials. Although members of group 4 tend to have the most disposable income, those in group 3 spend more money. Younger adults, presumably building their households, make more purchases of expensive “hard goods” (refrigerators, microwave ovens, automobiles, and so on). The coming of age of the baby-boom generation, in the late sixties and early seventies, created a profound marketing crisis. The top-rated sitcoms of the 1969–1970 season included *Mayberry*

R.F.D., *Family Affair*, *Here's Lucy*, and *The Doris Day Show*. Though all four of these programs were in Nielsen's top ten that season, their audience was concentrated outside of group 3. How could the networks deliver the new primary consumer group to the ad agencies and their clients? Norman Lear provided the networks with a new model that realistically addressed itself to this problem. In *Tube of Plenty* Erik Barnouw shows how the timidity of television narrative can be traced directly to the medium's birth during the McCarthy Era. If the sixties accomplished nothing else, it ended the McCarthy scare. The consensus imagery that had dominated the sitcom since the birth of TV simply could not deliver the new audience on the scale that the new consensus imagery that Norman Lear developed for the seventies could. Lear's break from the twenty-year-old style of the genre seemed self-consciously “hip.” The age of life-style was upon us.

In the fifties and sixties, sitcoms were offering the Depression-born post-Second World War adult group a vision of peaceful, prosperous suburban life centered on the stable nuclear family. In these shows—among them, *Father Knows Best*, *The Adventures of Ozzie and Harriet*, *The Donna Reed Show*, *The Trouble With Father*, *Make Room for Daddy*—actual humor (jokes or shticks) was always subordinate to the proper solution of ethical crises. They were comedies not so much in the popular sense as in Northrop Frye's sense of the word: no one got killed, and they ended with the restoration of order and happiness. What humor there was derived largely from the “cuteness” displayed by the children in their innocent but doomed attempts to deal with problems in other than correct (adult) ways. Sometimes an extra element of humor was injected by marginal characters from outside the nuclear family. Eddie Haskell (Ken Osmond) is among the best-remembered of these domestic antiheroes. A quintessential wise guy, Eddie deviated from the straight and narrow as walked by Wally Cleaver; this was implicitly blamed on his parents. The

fact that Eddie was uniformly punished by the scriptwriters made his rebellion all the more heroic.

Beneath the stylistic differences that separate a classic fifties sitcom and a Norman Lear show, the two are bound together by their unwavering commitment to didactic allegory. Lear indeed updated the conversation in the sitcom living room, but the form of his sitcoms was actually quite conservative. Like the sitcoms of the fifties, Lear's shows reinforced what Dorothy Rabinowitz has called "our most fashionable pieties." "Fashionable" is the key term. As Roger Rosenblatt has pointed out, the greatest difference between *Father Knows Best's* Jim Anderson and Archie Bunker is that Jim, the father, is the source of all wisdom for the Anderson family, whereas Archie is more likely to be the object of lessons than the source of them.

Perhaps the reason that the sitcom has been looked down upon by critics as a hopelessly "low" or "masscult" form is that a search for what Matthew Arnold called "the best that has been known and said" is a wild-goose chase as far as the genre is concerned. R. P. Blackmur, though certainly no TV fan, commented germanely in his essay "A Burden for Critics" that the critic "will impose the excellence of something he understands upon something he does not understand. Then all the richness of actual performance is gone. It is worth taking precautions to prevent that loss, or at any rate to keep us aware of the risk." Television is not yet a library with shelves; it is a flow of dreams, many remembered, many submerged. How can we create a bibliography of dreams? Blackmur also wrote that "the critic's job is to put us into maximum relation to the burden of our momentum." Television is the engine of our cultural momentum. It has heaped thousands upon thousands of images upon the national imagination:

Jackie Gleason rearing back a fist and threatening to send Alice to the moon.

Phil Silvers's bullet-mouthed Sergeant Bilko conning his platoon out of its paychecks.

Jack Benny and Rochester guiding an IRS man across a crocodile-infested moat to the vault.

Dobie Gillis standing in front of "The Thinker" and pining for Tuesday Weld.

Carroll O'Connor giving Meathead and modern philanthropic liberalism the raspberry.

Jerry Van Dyke settling in the driver's seat of a Model T Ford for a heart-to-heart talk with *My Mother, the Car*.

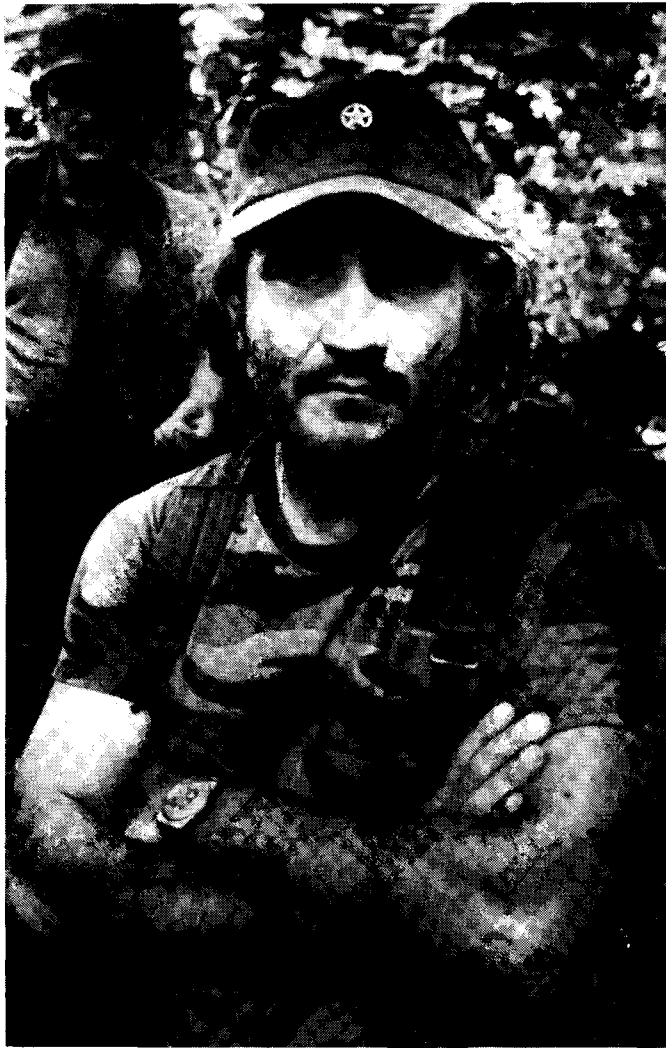
In *Democratic Vistas* Walt Whitman called for a new homegrown American literary art whose subject would be "the average, the bodily, the concrete, the democratic, the popular." The sitcom is an ironic twentieth-century fulfillment of this dream. The "average" has been computed and dramatized as archetype; the consumer world has been made "concrete"; the "bodily" has been fetishized as the object of unabashed envy and voyeurism—all of this is nothing if not "popular." The procession of images that was Whitman's own art, and that he hoped would become the nation's, is lacking in the sitcom in but one respect: the technique of television art is not democratic but demogra-

phic. The producers, directors, writers, camera operators, set designers, and other artists of the medium are not, as Whitman had hoped, "breathing into it a new breath of life." Instead, for the sake of increased consumption they have contractually agreed to create the hallucinations of what Allen Ginsberg has called "the narcotic . . . haze of capitalism." The drug indeed is on the air and in the air. Fortunately, the integrity of the individual resides in the autonomy of the imagination, and is not curtailed by this system. The television set plays on and on in the mental hospital; the patient can sit in his chair, spaced-out and hopeless, or rise to the occasion of consciousness.

IN FRONT OF THE CURTAIN

"THE VIRTUE OF [PROFESSIONAL] WRESTLING," Roland Barthes wrote in 1957, "is that it is the spectacle of excess." The sitcom, in contrast, is a spectacle of subtleties, an incremental construction of substitute universes laid upon the foundation of a linear, didactic teletheater. Even the occasional insertion of the *mirabile* or supernatural underlines the genre's broader commitment to naturalistic imitation. Presentational comedy, which shared the prime-time limelight with the sitcom during the early years of TV, vacillates between the danger of excess and the safety of consensus. The comedy-variety genre has been the great showcase for presentational teleforms: stand-up comedy, impersonation, and the blackout sketch. It is similar to wrestling, in that it too strives for the spectacle of excess. The pre-electronic ancestors of the TV comedy-variety show can be found on the vaudeville and burlesque stages: the distensions of the seltzer bottle and the banana peel; the fantastic transformations brought about by mimicry; the titillating physical, psychological, and cultural disorders that abound in frankly self-conscious art forms. But the comedy-variety show does not go to the ultimate excesses of wrestling. Like the sitcom, it is framed by the proscenium arch and accepts the badge of artifice.

While the representational genres—the sitcom and its cousins, the action/adventure series and the made-for-TV movie—have flourished to the point that they consume almost all of the "most-watched" hours, the comedy-variety show has been in steady decline since the 1950s, when it was a dominant formula for prime-time television. Since the self-imposed cancellation of *The Carol Burnett Show*, in 1978, the few presentational variety hours that have appeared in prime time have been hosted by singers (Barbara Mandrell, Marie Osmond), and comedy has been relegated to a rather pathetic supporting role. The fall of the genre took place amid increasing demand for a "product" as opposed to a "show" in the growing television industry. As the prime-time stakes rocketed upward, sponsors, agencies, and networks became less tolerant of the inevitable ups and downs of star-centered presentational comedy. The sitcom and other forms of representational drama offer relatively rigid shooting scripts that make "quality con-



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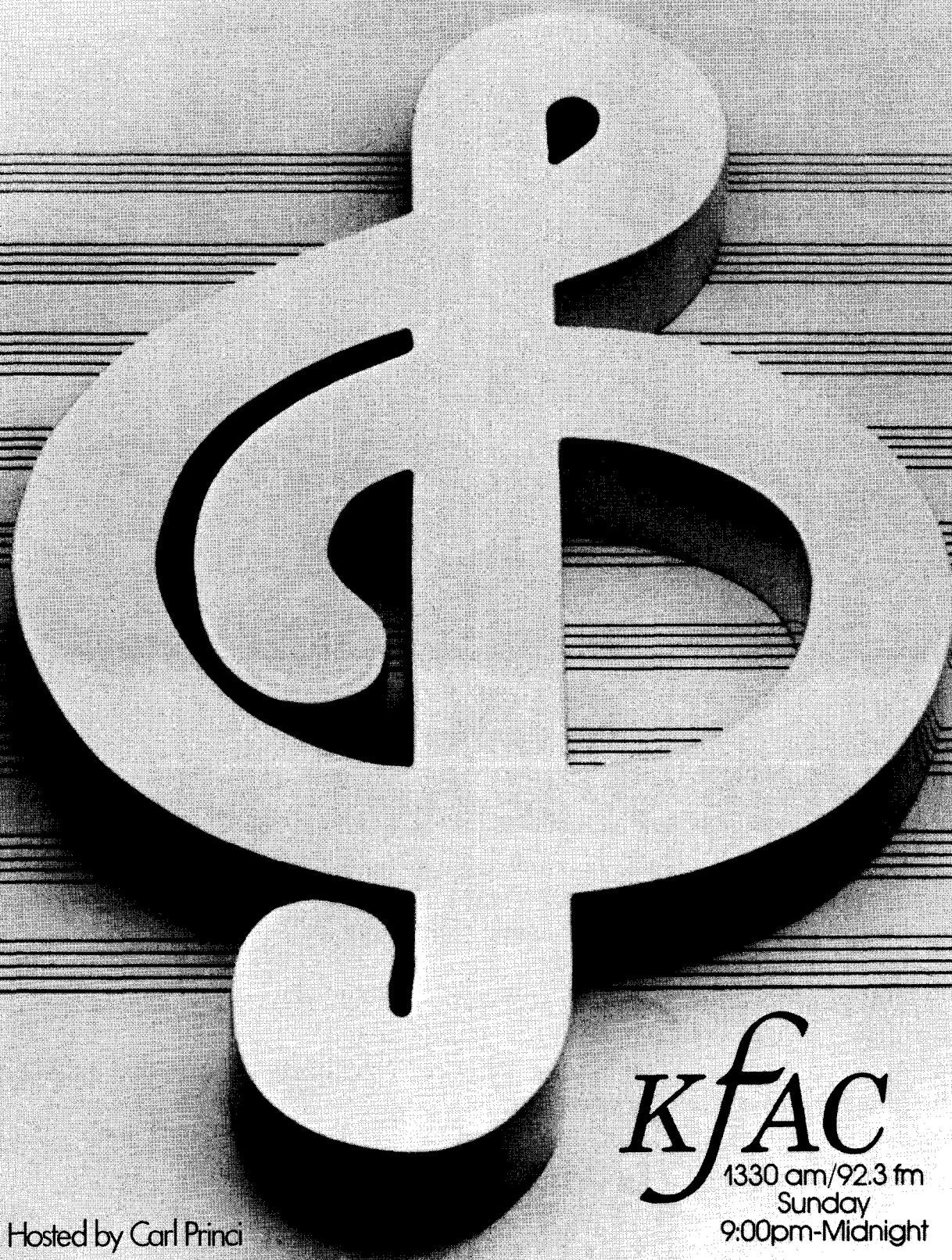


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trol" easier to impose. Positive demographic responses to dramatic "concepts" are dependable barometers. Performance comedy is only as good as an individual performance; the human element looms too large. Furthermore, representational drama can avoid the dreaded extremes of presentational comedy. Kinescopes of early Milton Berle shows reveal the comedian in transvestite sketches whose gratuitous lewdness rivals that of wrestling at its most intense. The passionate vulgarity of these sketches could not have been wholly predictable from their scripts. Instead, it derives directly from Berle's confrontation with the camera—his performance. Censorship of such material presents complex editing problems, which are easily forestalled in representational drama by script changes.

Berle's nova-like career is itself an illustration of the fragility of comedy-variety on television. NBC signed "Mr. Television" to a thirty-year contract in 1951; by the end of the decade he had become an embarrassment to the network and was being used as the host of a bowling show. The message was clear: Berlesque, like wrestling, had been blackballed from television's increasingly genteel prime-time circle. The late fifties, the heyday of *Playhouse 90*, *The U.S. Steel Hour*, and *The Armstrong Circle Theater*, was the "golden age of television drama." TV then, as now and always, was on the verge of becoming sophisticated. The NBC late-night spot passed from the wacky Jerry Lester to the neurotically urbane Jack Paar. Berle was certainly neurotic; he simply could not be urbane.

Generally speaking, the comedian has had to frame himself with the proscenium arch and don the mask of a representational character to find a place in prime-time television. The networks have thus provided themselves with a modicum of protection from the unreliability of personalities. Presentational comedy—performance art—may simply be too dangerous a gamble for the high stakes of today's market.

Interestingly, the disappearance from TV of the clown who faces the audience without a story line has occurred more or less simultaneously with rising interest in and appreciation of performance art in avant-garde circles. In "Performance as News: Notes on an Intermedia Guerrilla Art Group" Cheryl Bernstein wrote:

In performance art, the artist is more exposed than ever before. The literal identification of artistic risk with the act of risking one's body or one's civil rights has become familiar in the work of such artists as Chris Burden, Rudolf Schwarzkogler, Tony Schafrazi and Jean Toche.

Burden invites an audience into a performance space where spectators sit atop wooden ladders. He then floods the room with water and drops a live electrical wire into the giant puddle. The closest thing television offers to a spectacle of this kind is Don Rickles, who evokes terror in an audience by throwing the live wire of his insult humor into the swamp of American racial and ethnic fears. Rickles, for the most part, has been prohibited from performing his intense theater of humiliation in prime time.

Twice the networks have attempted to contain him in sitcom proscenium, but these frames have constricted his effect and turned his insults into dull banter. In recent years he has rarely been unleashed upon live studio audiences. The erratic quality of his occasional performances as guest host on *The Tonight Show* offers a clue to the networks' reluctance to invest heavily in the presentational comedy form.

Bernstein points to the news as the great source of modern performance art on television. She deconstructs the kidnapping of Patty Hearst by the Symbionese Liberation Army as a performance work. The SLA was a troupe formed to create a multimedia work—the kidnapping—principally for television. The mass distribution of food in poor neighborhoods in the San Francisco Bay area (in compliance with one of the SLA's demands) and the shoot-outs and police chases were all part of a modern theatrical art that can exist only on television. Perhaps the proliferation of the news on television can be tied to the decline of presentational comedy; the two seem to have occurred in direct proportion to each other. The schlockumentary magazine (*Real People*, *That's Incredible!*) is the point at which the two genres meet.

Furthermore, the bombardment of the home screen with direct presentations from every corner of the earth has created a kind of vaudeville show of history. The tensions generated by the nuclear Sword of Damocles create a more compelling package than even Ed Sullivan could have hoped to assemble. The nations of the world have become a troupe of baggy-pants clowns on TV. They are trotted out dozens of times each day in a low sketch comedy of hostility, violence, and affectation. The main show, of course, is the network evening news. Climb the World Trade Center. Fly an airplane through the Arc de Triomphe. Plant a bomb in a department store in the name of justice. Invade a preindustrial nation with tanks in the name of peace. Can Ted Mack compare with this?

THE THEATER COLLAPSES

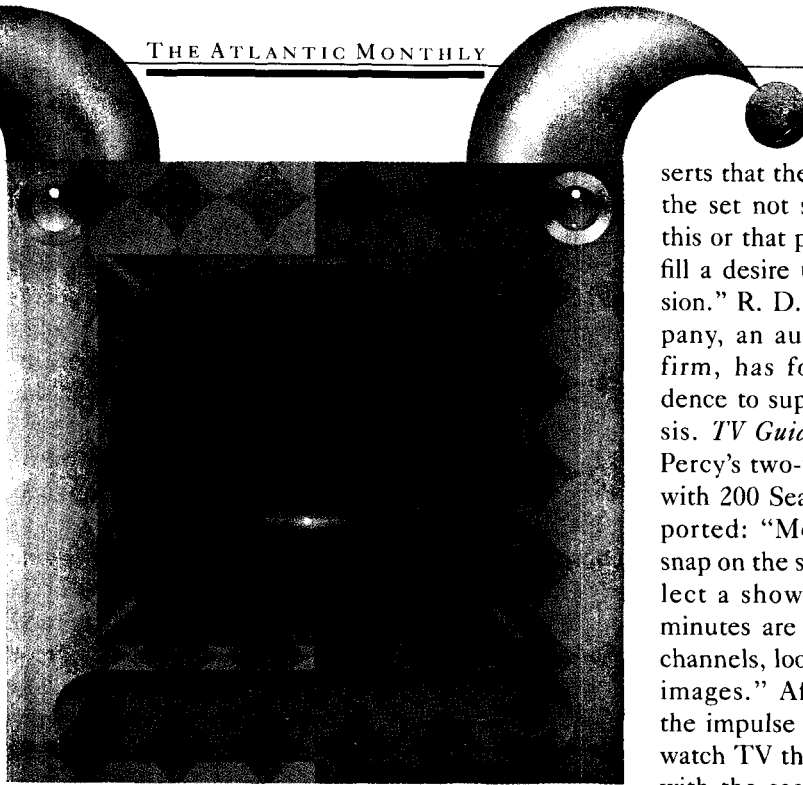
THE TELEVISION INDUSTRY IS AT THE HEART OF A vast entertainment complex that oversees the coordination of consumption and culture. "Entertainment" has been established as a buzz word for narrative and other imaginative presentations that make money. It is used as a rhetorical ploy to specialize popular arts and isolate them from the aesthetic and political scrutiny reserved for "art." An important implication of the definition of *entertain* is the intimate social relationship it implies between the entertainer and the entertained. In 1956 Gunther Anders wrote that the "television viewer, although living in an alienated world, is made to believe that he is on a footing of the greatest intimacy with everything and everybody." The technological means to produce this illusion have since been significantly enhanced. Anders described this illusion as "chumminess." Television offers itself to the viewer as a hospitable friend: Welcome to *The Wonderful World of Disney*. Good evening, folks. We'll be

right back. See you next week. Y'all come back, now. As technology synthesizes more and more previously human functions, there is a proliferation of anthropomorphic metaphor: automated teller machines ask us how much money we need. Computers send us bills. Channel 7 is predicting snow. The car won't start. It is in this context that television entertains. There is an odd sensation of titillation in all this service. Whitman and other nineteenth-century optimists foresaw an elevation of the common man to a proud master in the technoworld. Machines would take care of life's dirty work—slavery without guilt. Television enthusiastically smiles and shuffles for the viewer's favor. Even television programs we do not like contribute to the illusion (that is, "We are not amused"). Success in tele-American life is measured largely by the quantity of machines at one's disposal. Are all the household chores mechanized? Do you have HBO? Work is minimized. Leisure is maximized. There is more time to watch television—to live like a king.

Backstage of this public drama a quite different set of relationships is at work. In a demography the marketing apparatus becomes synonymous with the state. As the quality of goods takes a back seat to the quantity of services, the most valued commodity of all—the measure of truth—becomes information on the consuming preferences of the hundreds of millions of consumer-kings. Every ticket to the movies, every book, every tube of toothpaste purchased is a vote. The shelves of the supermarkets are stocked with referenda. Watching television is an act of citizenship, participation in culture. The networks entertain the viewer; in return, the viewer entertains thousands of notions on what to buy (that is, how to live). The democrat Whitman wrote that the most important person in any society is the "average man." The demographer Nielsen cannot agree more:

While the average household viewed over 49 hours of television per week in the fall of 1980, certain types viewed considerably more hours. Households with 3 or more people and those with non-adults watched over 60 hours a week. Cable subscribing households viewed about 7 hours a week more than non-cable households.

Paul Klein, the chief programmer at NBC in the late seventies, built his programming philosophy upon what he called the Least Objectionable Program (LOP) theory. This theory, expounded by Klein, plays down the importance of viewer loyalty to specific programs. It as-



serts that the viewer turns on the set not so much to view this or that program as to fulfill a desire to "watch television." R. D. Percy and Company, an audience-research firm, has found some evidence to support Klein's thesis. *TV Guide*, summarizing Percy's two-year experiment with 200 Seattle families, reported: "Most of us simply snap on the set rather than select a show. The first five minutes are spent *prospecting* channels, looking for gripping images." After giving in to the impulse (compulsion?) to watch TV the viewer is faced with the secondary consider-

ation of choosing a program. In evolved cable markets this can mean confronting dozens of possibilities. The low social prestige of TV watching, even among heavy viewers, coupled with the remarkably narrow range of what is usually available, inhibits the viewer from expressing enthusiasm for any given show. The viewer or viewers (watching TV, it must not be forgotten, is one of the chief social activities of the culture) must therefore "LOP" about, looking for the least bad, least embarrassing, or otherwise least objectionable program. While I am ill prepared to speculate on the demographic truth of this picture of the "average man," two things are worth noting: anyone who watches television has surely experienced the LOP phenomenon; and NBC fell into last place in the ratings under Klein's stewardship.

I cite Klein (and Nielsen) to demonstrate the character of demographic thought, the ideology that ultimately produces most television programs and that is always employed to authorize or censor their exhibition on the distribution system. The optimistic, democratic view of man as a self-perfecting individual, limited only by superimposed circumstance, is turned on its head. Man is defined as a prisoner of limitations who takes the path of least resistance. This is an industrial nightmare, the gray dream of Fritz Lang's *Metropolis* reshot in glossy Technicolor. Workers return from their multicollared tasks drained of all taste and personality. They seek nothing more than merciful release from the day's production pressures, or as certain critics tell us, they want only to "escape."

"Escapism" is a much-used but puzzling term. Its ambiguities illustrate the overall bankruptcy of the television criticism that uses it as a flag. The television industry is only too happy to accept "escapism" as the definition of its work; the idea constitutes a carte-blanche release from responsibility for what is presented. Escapism critics seem to believe that the value of art should be measured only by rigorously naturalistic standards. Television programs are

viewed as worthless or destructive because they divert consciousness from "reality" to fantasy. However, all art, even social realism, does this. Brecht was certainly mindful of this fact when he found it necessary to attach intrusive Marxist sermons to the fringes of social-realist stage plays. Is metaphor possible at all without "escapism"? Presumably, the mechanism of metaphor is to call a thing something it is not in order to demonstrate emphatically what it is. When the network voice of control says, "NBC is proud as a peacock," it is asking the recipient of this message to "escape" from all realistic data about the corporate institution NBC into a fantastic image of a bird displaying its colorful feathers in a grand and striking manner. The request is made on the assumption that the recipient will be able to sort the shared features of the two entities from the irrelevant features and "return" to a clearer picture of the corporation. Representational television programs work in much the same way. If there were no recognizable features of family life in *The Waltons*, if there were no shared features of life-style in *Three's Company*, if there were no credible features of urban paranoia in *Baretta*, then watching these shows would truly be "escapism." But if those features are there, the viewer is engaging in an act that does not differ in essence from reading a Zola novel. The anti-escapist argument makes a better point about the structure of narrative in the television series. In the world of the series problems are not only solvable but usually solved. To accept this as "realistic" is indeed an escape from the planet Earth. But how many viewers accept a TV series as realistic in this sense? Interestingly, it is the soap opera—the one genre of series television that is committed to an anticlimactic, existential narrative structure—that has created the most compelling illusion of realism for the viewing audience. The survival and triumphs of an action-series hero are neither convincing nor surprising but merely a convention of the medium. Like the theater audience that attends *The Tragedy of Hamlet*, the TV audience knows what the outcome will be before the curtain goes up. The seduction is not What? but How?

THUS FAR, I HAVE LIMITED MY DISCUSSION TO traditional ways of looking at television. However, the television industry has made a commitment to relentless technological innovation of the medium. The cable converter has already made the traditional tuner obsolete. From a comfortable vantage point anywhere in the room the viewer can scan dozens of channels with a fingertip. From the decadent splendor of a divan the viewer is less committed to the inertia of program choice. It is possible to watch half a dozen shows more or less simultaneously, fixing on an image for the duration of its allure, dismissing it as its force disintegrates, and returning to the scan mode. Unscheduled programming emerges as the viewer assumes control of montage. It is also clear that program choice is expanding. The grass-roots public-access movement is still in its infancy, but the network *mise en scène* has

been somewhat augmented by new corporate players such as the superstations and the premium services. Cheap home recording and editing equipment may turn the television receiver into a bottomless pit of "footage" for any artist who dares use it.

Michael Smith, a Chicago-born New York grantee/comedian, is among those pointing the way in this respect. Whether dancing with *Donny and Marie*, in front of a giant video screen, at the Museum of Contemporary Art, in Chicago, or performing rap songs at the Institute of Contemporary Art, in Boston, Smith offers an unabashed display of embarrassments and highlights in the day of a life with television. Mike (Smith's master persona) is the star of his own videotapes (that is, TV shows). In "It Starts at Home" Mike gets cable and learns the true meaning of public access. In "Secret Horror" reception is plagued by ghosts. The passive viewer—that well-known zombie who has been blamed for every American problem from the Vietnam War to Japanese technological hegemony—becomes a do-it-yourself artist in Smith. If, as Susan Sontag writes, "interpretation is the revenge of the intellect upon art," parody is the special revenge of the viewer upon TV.

Whatever the so-called blue-sky technologies bring, there can be no doubt that the enormous body of video text generated during the decades of the network era will make itself felt in what will follow. The shows and commercials and systems of signs and gestures that the networks have presented for the past thirty-five years constitute the television we know how to watch. There won't be a future without a past.

In *Popular Culture and High Culture* Herbert Gans took the position that all human beings have aesthetic urges and are receptive to symbolic expressions of their wishes and fears. As simple and obvious as Gans's assertion seems, it is the wild card in the otherwise stacked deck of demographic culture. Paul Buhle and Daniel Czitrom have written,

We believe that the population at large shares a definite history in modern popular culture and is, on some levels, increasingly aware of that history. We do not think that the masses of television viewers, radio listeners, moviegoers, and magazine readers are numbed and insensible, incapable of understanding their fate or historical condition until a group of "advanced revolutionaries" explains it to them.

Evidence of this shared, definite history, in the form of self-referential parody, is already finding its way to the air. The television babies are beginning to make television shows. In the signature montage that introduces each week's episode of *SCTV*, there is a shot of a large apartment house with dozens of televisions flying out the windows and crashing to the ground. As the viewer learns, this does not mean the end of TV in Jerry Mander's sense but signifies the end of television as it has traditionally been experienced. *SCTV* is television beginning to begin again. The familiar theatrical notions of representation and presentation that have guided the development of programming genres are ground to fine dust in the crucible of a sat-

ire that draws its inspiration directly from the experience of watching television. *SCTV* has been the first television program absolutely to demand of its viewers a knowledge of the traditions of TV, a self-conscious awareness of cultural history. In such a context viewing at last becomes an active process. Without a well-developed knowledge of and sensitivity to the taxonomy and individual texts of the first thirty-five years of TV, *SCTV* is meaningless—and probably not even funny. In 1953 Dwight Macdonald described “Mass Culture” as “a parasitic, a cancerous growth on High Culture.” By this, I take it, he meant that mass-consumed cultural items such as television programs “steal” the forms of “High Culture,” reduce their complexity, and replace their content with infantile or worthless substitutes. The relationship of mass culture to high culture, Macdonald told us, “is not that of the leaf and the branch but rather that of the caterpillar and the leaf.” *SCTV* bears no such relationship to any so-called high culture. It is a work that emerges out of the culture of television itself, a fully realized work in which history and art synthesize the conditions for a new consciousness of both. Other media— theater, film, radio, music—do not bend the show to televised renderings of their own forms but instead are forced to become television. The viewer is not pandered to with the apologetic overdefining of linear development that denies much of television its potential force. Presentation and representation merge into a seamless whole. The ersatz proscenium theater used by the networks to create marketing genres is smashed; the true montage beaming into the television home refuses to cover itself with superficial framing devices. The pseudo-Marxist supposition that *SCTV* is still guilty of selling the products is boring—the show is not.

SCTV is among the first tangible signs of a critical relationship to TV viewing that is more widespread than a reading of the TV critics would indicate. American TV was born a bastard art of mass-marketing theory and recognizable forms of popular culture. Thirty-five years later a generation finds in this dubious pedigree its identity and heritage. The poverty of TV drama in all traditional senses is not as important as the richness of the montage. For the TV-lifer, a rerun of *Leave It to Beaver* or *I Love Lucy* or *The Twilight Zone* offers the sensation of traveling through time in one’s own life and cultural history. The recognizable, formulaic narrative releases the viewer from what becomes the superficial concerns of suspense and character development. The greater imaginative adventures of movement through time, space, and culture take precedence over the flimsy mimesis that seems to be the intention of the scripts. The whole fast-food smorgasbord of American culture is laid out for consumption. This is not merely kitsch. Clement Greenberg wrote that “the precondition for kitsch [the German word for mass culture], a condition without which kitsch would be impossible, is the availability close at hand of a fully matured cultural tradition, whose discoveries, acquisitions, and perfected self-consciousness kitsch can take advantage of for its own ends.”

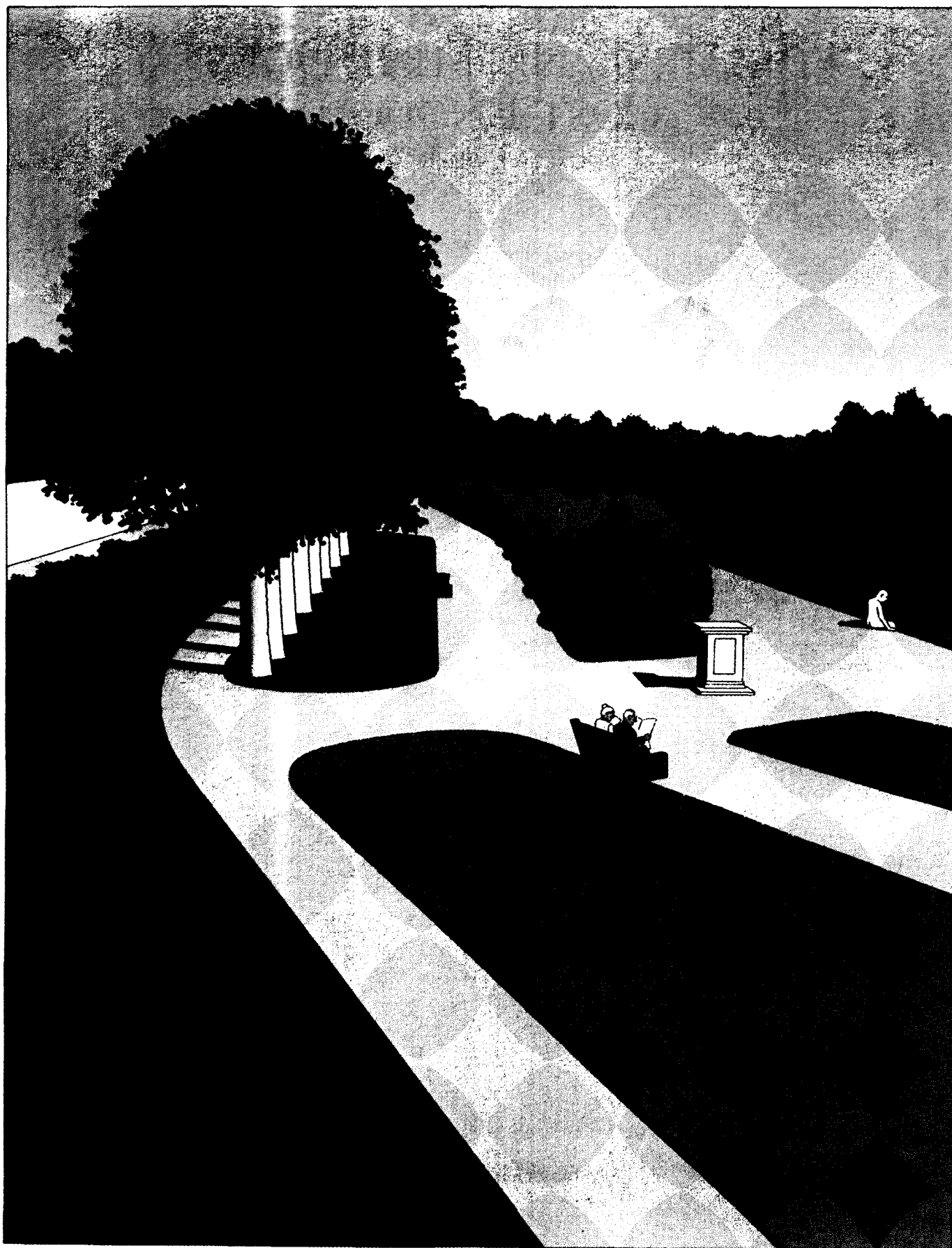
In fact, this process is reversed in television appreciation. The referent culture has become the mass, or kitsch, culture. Instead of masscult ripping off highcult, we have art being fashioned from the junk pile. The banal hysteria of the supermarket is capable of elegant clarity in Andy Warhol’s *Campbell’s Soup Can*. Experience is re-formed and re-contextualized, reclaimed from chaos. Television offers many opportunities of this kind.

The networks and ad agencies care little about these particulars of culture and criticism. The networks promise to deliver heads in front of sets and no more. But, as we will find in any hierarchical or “downstream” system, there is a personal stance that will at least allow the subject of institutional power to maintain personal dignity. In the television demography this stance gains its power from the act of recontextualization. If there is no exit from the demographic theater, each viewer will have to pull down the rafters from within. What will remote-control “SOUND: OFF” buttons mean to the future of marketing? What images are filling the imaginations of people as they “listen” to television on the TV bands of transistor radios, wearing headphones while walking the streets of the cities? Why are silent TV screens playing at social gatherings? When will the average “Household Using TV” (HUT) be equipped with split-screen, multichannel capability? What is interesting about a game show? The suspense as to who will win, or the spectacle of people brought frothing to the point of hysteria at the prospect of a new microwave oven? What is interesting about a cop show? The “catharsis” of witnessing the punishment of the criminal for his misdeeds, or the attitude of the cop toward evil? What is interesting about a sitcom? The funniness of the jokes, or the underlining of the jokes on the laugh track? The plausibility of the plot, or the portrayal of a particular style of living as “normal”? What is interesting about Suzanne Somers and Erik Estrada? Their acting, or their bodies? Television is made to sell products but is used for quite different purposes by lonely, alienated people, families, marijuana smokers, born-again Christians, alcoholics, Hasidic Jews, destitute people, millionaires, jocks, shut-ins, illiterates, hang-gliding enthusiasts, intellectuals, and the vast, heterogeneous procession that continues to be American culture in spite of all demographic odds. If demography is an attack on the individual, then the resilience of the human spirit must welcome the test.

“To be a voter with the rest is not so much,” Whitman warned in his *Democratic Vistas* of 1871. The shopper/citizen of the demography ought to know this only too well. Whitman recognized that no political system could ever summarily grant its citizens freedom. Government is a system of power; freedom is a function of personality. “What have we here [in America],” he asked, “if not, towering above all talk and argument, the plentifully-supplied, last-needed proof of democracy, in its personalities?” Television is the Rorschach test of the American personality. I hope the social psychologists will not find our responses lacking. □

AFTERNOON

BY GUY BILLOUT



*A reliable and relatively cheap fighter
is being ignored by the Air Force, because the Air Force didn't design it*

THE AIRPLANE THAT DOESN'T COST ENOUGH

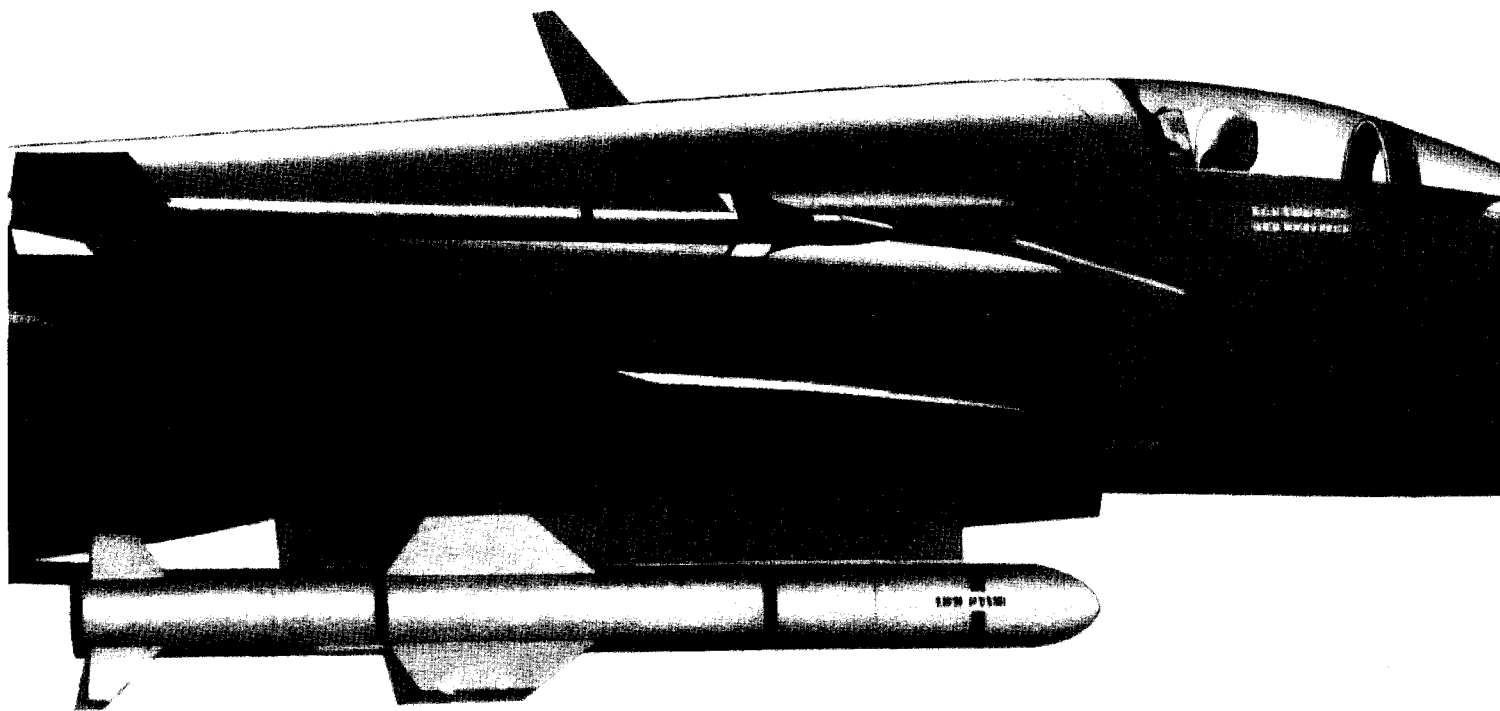
BY GREGG EASTERBROOK

LATE IN THE 1970S OFFICIALS OF THE CARTER ADMINISTRATION began to worry that American fighter aircraft might be too glamorous for the country's own good. Nearly all of our foreign military clients were asking for the same frontline fighters—mainly F-15s and F-16s—that were being built for the Pentagon, whether or not their security needs justified such aircraft, whether or not their air forces actually could use the planes in combat (even the U.S. Air Force was having trouble keeping the F-15 flying), and whether or not they could afford to buy from the top shelf. Military and technological status-seeking appeared to have routed common sense in many governments. Iran had demanded and received the extraordinarily complex F-14, which the Shah (and his successors) would never be able to maintain. Saudi Arabia was raising a storm in Congress by insisting on the F-15. Many poor countries—Turkey, Pakistan, Egypt, Taiwan, Spain,

South Korea, Singapore, and Venezuela, among others—were agitating for the only slightly less impressive F-16 and F-18. Most phrased their desire for frontline fighters in terms of a test of American support and intentions—a shrewd tactic, because hardly anyone could argue with a straight face that such planes would be in a developing country's best political or economic interests. Many foreign buyers were not deterred by the expense of these aircraft, because Uncle Sam was picking up at least part of the tab through concessionary loans or outright grants.

Convinced that the situation was getting out of hand, President Jimmy Carter decided that what was needed was a new fighter plane designed specifically for foreign customers. This plane would be cheaper, simpler, and less powerful than top-shelf U.S. fighters; descriptions like "intermediate," "medium capable," and "degraded" were used to describe the projected machine. Carter asked defense contractors to develop such a product at their own expense and risk. Naturally, no client would want a "de-

Gregg Easterbrook is a staff writer for The Atlantic.



graded" fighter plane, but Carter assured contractors that the State Department would create a market for one all the same, by refusing to license the Pentagon's best for export. The details of the plan were ironed out in 1979, and a program to develop a fighter (referred to as the FX) for foreign markets was set in motion.

The goals of the FX program—low cost and ease of maintenance—were well suited to the interests of U.S. foreign policy. When a developing country goes into debt to acquire weapons, it weakens its economy and diverts resources from its citizens, worsening the "political, social, and economic problems on which revolutionary movements thrive," as General John Vessey, Jr., the chairman of the Joint Chiefs of Staff, recently told a congressional committee. (Pakistan, for example, one of the poorest countries in the world, spent nearly a billion dollars of its own money in 1981 to acquire forty F-16s, an act that an impartial referee might consider criminal.) The purchase of American fighters involves more than the aircraft themselves. American military personnel must accompany the planes to instruct the client in their use and to stand guard over classified technology; usually, employees of the contractor go along as well, to try to keep the planes running. At present some 250 U.S. citizens are living in Saudi Arabia to assist the Saudi air force with its sixty F-15s; generally, at least two civilian technicians follow every F-16 sold. Besides being a large hidden expense, such personnel would make excellent hostages.

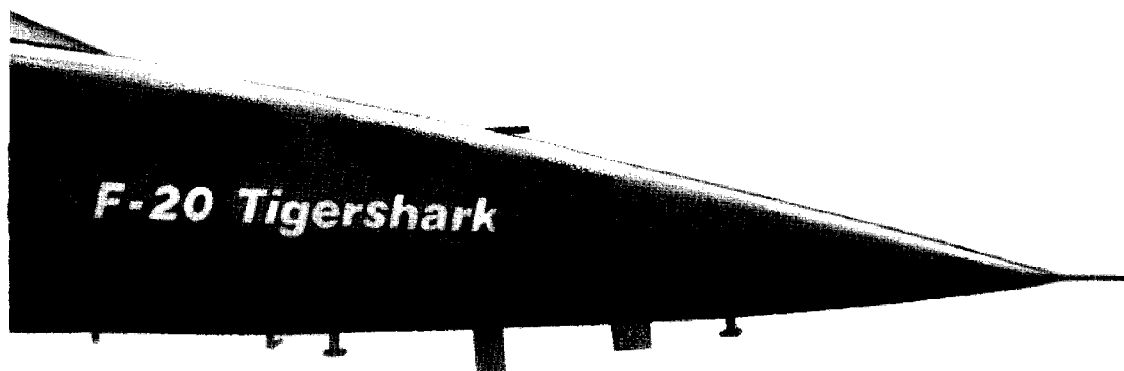
Perhaps most important from the perspective of U.S. interests, if a weapon we sell cannot be made to work, it cannot serve even the legitimate defense purposes of our cli-

ents. If Pakistan is attacked and its American-made fighters cannot respond, not only will the money spent to buy them have been wasted but also the U.S. military will be under added pressure to step in—with all the cost, loss of American lives, and political risk that such intervention entails. In short, an airplane cheaper to buy and easier to run than the frontline fighters could serve U.S. objectives, by allowing our clients to defend themselves on their own.

Today two FX-class aircraft are flying. One, the General Dynamics F-16/79, is a "degraded" F-16—the standard Air Force fighter with some electronics removed and an older, less powerful engine substituted for the one used by American forces. The other FX-class aircraft, the Northrop F-20, is almost entirely new. Rather than use degraded versions of existing equipment, Northrop employed cheaper new equipment, for which the Pentagon had not issued requirements. The F-20 has turned out, as planned, to be much cheaper overall than frontline U.S. fighters, and easier to service. But something quite unexpected has also been achieved: the F-20 may be as *good* as the best fighters—nearly equal to the F-15 or the F-16 in some respects, and superior to them in others. According to some Air Force pilots, in combat with frontline Air Force planes F-20s could win.

No such trial encounter is scheduled, however. The Pentagon is doing its best to ignore the F-20: it won't consider adding the plane to the active American inventory, and, according to knowledgeable sources, it is dissuading foreign customers from buying the plane. (So far, no F-20s have been sold.)

Northrop was supposed to build a little sister for U.S.



fighters, not a rival. That an aircraft on a par with the Air Force's best could be developed in just a few years at considerably less expense, for sale at a much lower purchase price, reflects badly on the Air Force's own fighter projects; it also threatens the contractors and service bureaucracies whose profits and budget allocations depend on safeguarding the status quo. And the fact that a high-performance jet fighter that is not a mechanic's nightmare could be built *at all* embarrasses the Air Force, which has never succeeded in building such a plane.

How could the F-20 be cheaper than frontline Air Force fighters and also be as good? The answer is largely that the F-20 was developed under free-enterprise standards of the sort that the Pentagon regularly espouses but rarely practices. In addition, the plane's designers confined themselves to seeking reasonable solutions to the realities of combat, rather than pushing to meet the outer limits of theoretical scenarios. The resulting airplane offers not only an opportunity to reduce the defense budget today but also a model for keeping it down—while improving the country's military readiness—in the future.

ALTHOUGH GENERAL DYNAMICS SIGNED ON TO THE FX program, it apparently did so without enthusiasm. After all, the company was selling fully loaded F-16s as fast as it could make them, to the U.S. Air Force, to Israel, and to several of our NATO allies. Most potential buyers of the FX really wanted the F-16, especially if they didn't have to pay for it in full. So General Dynamics knew that if it succeeded in building a cheap and attractive alternative to the F-16, it might be stealing business from itself. Some say that the company participated in the FX program only as a hedge against the chance that Carter would be re-elected and would make good his threat to forbid foreign sales of frontline planes.

Northrop, on the other hand, entered the FX program eagerly. The company needed the work. Although Northrop was prosperous—it builds part of the Navy's new F-18 fighter, guidance mechanisms for the MX, and the fuselage of the 747 transport, and (perhaps most important) it has won the early contracts for the Stealth bomber—its export business was dying. For two decades Northrop had been building and selling overseas the F-5, a low-cost fighter much admired for its reliability and compactness but by the late 1970s outclassed by Russian and French export fighters. Northrop had also suffered two painful defeats in bids for Air Force business. The company's prototype for an anti-tank plane lost in a "fly-off" against the A-10 prototype by Fairchild Industries; its prototype for the next major American fighter was bested by General Dynamics's F-16.

Northrop's first inclination was simply to give its old F-5 fighter a hot new engine and call it an FX. But then officials began to reflect on what they had learned in the course of building the company's two rejected prototypes, and also on the aerospace technology that had been devel-

oped since the Air Force's frontline planes had been conceived. The F-15, a huge "air-superiority" fighter beloved by Air Force generals for its power and stunning appearance, was designed in the late 1960s; the F-16 was designed in the early 1970s. The engineering of both planes preceded the explosion of progress in silicon chips and miniature computers. Also, both planes are burdened with the Pratt & Whitney F100 jet engine, which is extremely powerful but rife with mechanical problems and prone to spontaneous stall-outs. Stall-outs can be deadly in planes equipped with only one engine, like the F-16. Recently the F100 engine's high maintenance costs have been the subject of a number of news reports; it was discovered, for instance, that Pratt & Whitney was billing the Air Force \$17.59 for a bolt that it had contracted to supply for sixty-seven cents. Last year the Air Force's budget for the F100's spare parts alone was \$628 million, and problems with the engine have become so severe that the service held an unprecedented "rebidding" of the supply contract, and has taken most of the business away from Pratt & Whitney.

Northrop decided to build a new airplane that would be modeled only loosely on the F-5. Central to the new design would be General Electric's F404 engine, just developed for the Navy's F-18. At the Navy's insistence engineers of the F404 had observed a novel precept in fighter-engine design: slightly less than the maximum thrust possible in exchange for greater reliability. Squeezing the last five to ten percent of power from an engine can cost as much, in money and reliability, as building in the first 90 to 95 percent. "It's the last few pounds of thrust, the last turn of the crank, that fouls up everything else," one retired Air Force colonel says. The F404 produces six percent less thrust per pound of internal weight than the F100 engine does, but it has 19,000 fewer parts. And the F404 is modular, so that if something goes wrong, only the failed section, rather than the entire engine, needs to be removed. (Anyone who has tried to change the seventh and eighth spark plugs on a 1975 Chevrolet Monza, a job that entails loosening the block mounts and moving the engine forward, will appreciate the difference.) The Navy plane for which the F404 had been designed is heavy and uses two engines; Northrop realized that a single F404 in a smaller fighter would yield high performance at a bargain price.

The F-20's navigational device is used on Boeing's new 757 and 767 passenger airliners. Most of the frontline fighters employ gyroscopes for guidance information; the nonmechanical system on the F-20 compares the frequencies of laser beams. Because it has no internal moving parts, its "mean time between failures" (as engineers say) is 2,000 hours; the gyroscope system on the F-16 has a mean time between failures of only 750 hours. The F-20's navigational system is also substantially less temperamental than those of other fighters. Gyroscope systems require from ninety seconds to ten minutes to warm up and align themselves. The laser system can align itself in as little as

twenty-two seconds—an important consideration for fighter craft that must be ready to scramble.

For the F-20's radar Northrop picked a newly developed digital unit that is governed by boards of semiconductor chips. It performs as well as the radar on the F-16 does, and has roughly half as many parts, making it much less likely to break down—a welcome development considering that radar is one of the least reliable components of high-performance fighters. The F-15 radar's mean time between failures is forty hours; the F-16's is seventy-five hours. Silicon chips give the F-20's radar a mean time between failures of 200 hours.

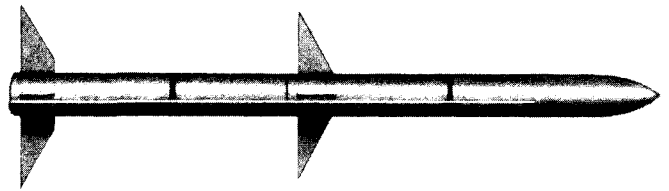
The small size of digital computers allowed Northrop's designers to add useful features to the radar without greatly increasing its size or weight. For example, the F-20 radar has a "freeze mode" that prevents the device from serving as a beacon for enemy planes. When the F-20 radar is switched to "freeze," it shuts off, but the plane's computer retains the last enemy position recorded and plots the F-20's movements relative to that position and relative to potential targets on the ground.

Vital flight information in the F-20 is projected onto a screen within the pilot's view so that he can watch his controls without lowering his eyes from the window. Flight commands are entered on a small keyboard just below the screen. In contrast, in some military fighters the pilot must turn to the side or even look at the floor to locate the right switch. The plane's software minimizes the routine tasks of flying. For example, whenever the engine is started, the radio and all other systems except the radar and the navigational device are automatically engaged; there's none of the throwing of toggle switches that is a familiar scene in the movies but a waste of time in war.

The F-20's digital circuitry is an example of technology that works, as opposed to technology for its own sake—a useful distinction in military procurement. In weaponry design, and in engineering in general, devices that are complicated, have many parts, or are required to perform at the limit of their capacity tend to fail. And yet some extremely sophisticated devices can be made dependable, as long as their design parameters are realistic and the technology employed is well understood, rather than experimental. For years the breakdown of the television set, with its hot vacuum tubes and motor-driven antenna, was a regular household occurrence. Today's television sets rarely break even though they are more advanced than older models. By the same token, a Macintosh computer is far more advanced than the original Univac, but more reliable as well. Its components are fewer, simpler, and tailored to everyday use. Practical advances in television sets, computers, and fighter planes are brought about by emphasizing what actually works instead of what would be nice if it did work. A technologically sophisticated machine does not have to be complicated.

An indication of the F-20's simplicity is the fact that of the more than sixty pilots (from foreign air forces as well as from the U.S. Air Force) who have flown Northrop's pro-

totypes, none has required more than two days of instruction on the flight simulator. One F-15 pilot from the Saudi air force asked if he could try to "fly" the simulator without being told anything at all about the F-20; he was able to do so without crashing. "The controls are so easy to learn and use, it's amazing," says Major Doug Pearson, an Air Force test pilot who has flown the F-15 and the F-16 and is currently assigned to test the F-20. Designers at Northrop explain that they engineered the controls to make them easy for pilots from less developed countries to master. But ease of control is as valuable to the most experienced pilot as it is to the least. "Why should a pilot be inundated with a lot of technical details when he's trying to fly and fight?" Pearson asks. "In a vintage [Second World War] plane you could concentrate on the stick, the throttle, and the trigger. This has some of that same quality."



THE DESIGNERS OF THE F-20 WERE ABLE TO EXPLOIT at least two other technological innovations unavailable to the designers of the F-15 or the F-16. One is a lightweight composite of graphite that takes the place of metal in some parts of a plane. The other is an improved version of the Sidewinder missile.

This Sidewinder has received little attention in the press, because on paper it is merely a refinement of a thirty-year-old weapon. Being neither "new" nor a "breakthrough," the upgraded Sidewinder has little glamour, but its effect on aerial battles could be profound. Since the original heat-seeking Sidewinder was invented, in the mid-1950s, it and similar, foreign-built models have been by far the most effective air-to-air missiles. Most of the missile "kills" recorded by the U.S. Air Force in Vietnam and by the Israelis in the 1967 and 1973 wars and in Lebanon were by Sidewinders. In 1982, when Navy F-14s, which were designed, at fantastic expense, to be "platforms" for radar-guided missiles, shot down two Libyan fighters, it was not the radar missiles but ordinary Sidewinders that were used.

The original Sidewinder works pretty much like a cannon. A pilot must close with his target aircraft and then maneuver in behind it so that the missile's infrared sensor can lock on to the heat of the target's engine. This requirement results in a dogfight, in which the two pilots turn ever-tightening circles as they try to obtain firing positions off each other's tails.

The new, "all-aspect" Sidewinder, however, can sense engine heat even when it is fired *in front* of a target. It can also sense heat across longer distances than the original Sidewinder can, and so it need not be aimed so precisely. This improvement enables pilots, in many situations, to avoid dogfights. According to informed defense-industry

sources, during the war in the Falklands British planes achieved two kills for every three all-aspect Sidewinders fired. During the Israeli–Syrian fighting in the Bekaa Valley that same year, when some fifty-five Russian-built MiGs were destroyed and only one Israeli plane was lost, two of the Israeli kills were achieved by air-to-air cannons, two by radar-guided missiles, and all the rest by Sidewinders, many of them the new version.

Why has this effective weapon, which it would seem the Pentagon ought to be crowing about, received little attention? For one thing, both the Air Force and the Navy have made widely publicized commitments to the radar-guided missile, staking the careers of hundreds of top officers and the budgets of several large bureaucracies on it. For another, Sidewinders cost a fraction of what radar-guided missiles do, so contractors are more eager to build the latter.

During the 1960s both Air Force and Navy planners assumed that radar-guided missiles—the latest thing in military technology—would be improved to such an extent

that they would be virtually unstoppable, whereas heat-seeking missiles, by then already an old idea, were as good as they were ever going to be. As a result, the F-15 was outfitted with a huge radar dish, was designed to fly very high and fast, and was made big enough to carry several radar-guided Sparrow missiles. A capacity to win in close combat was not a high priority in the development of the F-15, because the plane would always shoot from a distance—or so went the theory. Similarly, the Navy designed its most expensive fighter, the F-14, to accommodate the Sparrow and an even larger radar-guided missile: the Phoenix. As the expense of building these planes soared (today each costs about \$35 million), the limitations of radar-guided missiles became apparent. The Sparrow's "probability of kill" is supposed to be near 100 percent, but it has turned out to be much lower in practice. During the 1973 Arab–Israeli war, for example, of the twelve Sparrows fired, only one hit its target.

Although the all-aspect Sidewinder would appear to give the Air Force and the Navy exactly what they have so

THE STORM

After trimming the split trunk of our tallest maple,
we drove along the littered road to see
the other damage. On the next high ground,
the neighbors' white frame house was still intact,
but their porch was lined in black—like silk, that soft
when we touched it—a jagged hole where the switch box
used to be, where lightning entered. Indoors,
it had traced a map on the walls
as it traveled the wires behind the walls,
throwing out at every socket fists of fire only inches
from where they sat. No one had been hurt, no one
shocked or burned, but each needed
to tell us what had happened, still figuring
whether to count their luck as bad or good.

We took the long way back to check the creek
loosened from its channel into the fields,
crowding the cattle to an upper ridge,
the young sycamores along the bank
shorter now by half, forking
at water level, and the water red as rust,
swift, swirling the whipped limbs of the willow-oaks,
grazing the concrete bridge and full of trash.
My father explained the bloated lumps
as logs, or broken fence, and pointed out
the occasional shimmering arrow at the surface—
something alive and swimming with the current—

trying to make what we passed seem natural,
as my mother had calmed us
in the noise and flash and passion
we'd shuddered through the night before.
But already a smell was rising from the new river,
the bottomland, the small lost animals it swallowed.
And we were learning risk and consequence,
having seen the neighbors' yard:
strips of rubber in the trees and grass,
the poles unattached, the central silver cord
simply missing, that carried power in.

—Ellen Bryant Voigt

arduously pursued with radar missiles (a weapon with a high probability of striking its target), prestige and the career interests of officers in radar missiles take precedence over the poor combat performance of those missiles. The F-16, which is smaller and more nimble than the F-15, was intended to fire Sidewinders, but it is being modified by the Air Force so that it can also carry a new radar missile, called the AMRAAM. Early indications are that the AMRAAM will be a little more successful than the Sparrow, but not much more. (The missile has yet to be flight-tested.) The Air Force is considering adding AMRAAM missiles to the \$208 million B-1 bomber, which at present has no weapons with which to defend itself, and there has even been talk of building a *fighter* version of the B-1 that would carry racks of AMRAAMs. The Navy, for its part, has chosen the Sparrow for its new F-18, and is even buying Sparrows for mounting on ships.

In the Reagan Administration's 1985 defense budget Sparrows are listed at \$206,000 each. AMRAAMs are expected to cost about \$900,000 each. The all-aspect Sidewinder costs \$69,000.

BECAUSE AN ALL-ASPECT SIDEWINDER WEIGHS MUCH less than a radar-guided missile, the plane that carries it can be small—and in air-to-air combat the smaller plane has the advantage. During a series of combat exercises staged in the late 1970s by the Air Force at Nellis Air Force Base, in Nevada, small size enabled the underpowered and poorly equipped F-5 to sneak up on the far more capable F-15 and, frequently, score a kill. In many instances this happened simply because the F-5's pilot saw the target F-15 long before the pilot of the F-15 saw the F-5. (In these exercises pilots were required to see their targets and verify them as foe before firing—a rule that almost always prevails in actual combat.) Confronted with this evidence of the large, expensive F-15's vulnerability to small, cheap planes, the Air Force hierarchy took immediate action: it stopped holding such tests.

The F-15 is two and a half times larger than the F-20; the F-16 is a third larger. Unlike the F-5, the F-20 is nearly the equal of these frontline planes in power and equipment. How it would perform against them in combat exercises can only be guessed, because the Air Force seems determined to avoid such an experiment.

A small plane is harder to see not only with the eyes but also with radar. Radar is not omniscient: like the eye, it loses its effectiveness over distance. The F-15's radar, for example, can pick up an object the size of a passenger airliner from about seventy-five miles away, but cannot see another F-15 until it is about forty miles away, and cannot see an airplane the size of an F-20 until it draws within about thirty miles. Radar can be frustrated by curvilinear shapes, which make poor reflectors of a radar's beam, and by polymer materials, which absorb the beam altogether. Perfecting these radar-foiling techniques is the object of the Air Force's "stealth" project. Small size, the simplest

and most basic stealth feature, is drawing little attention from the Pentagon's researchers, however, because small planes excite neither Air Force generals nor congressmen seeking to make dramatic election-year announcements. Preliminary designs of the much-heralded Stealth bomber project a weight of 550,000 pounds—*greater* than that of the B-52, the largest bomber flying. If the Stealth bomber turns out to be this large, effective anti-radar technology will be needed just to make the plane *no more* vulnerable to radar than existing aircraft are, to say nothing of making it "invisible."

The F-16 and the F-20 have the same top speed, but a plane's top speed is almost irrelevant to the demands of combat. When the afterburner, which is needed for a plane to achieve maximum acceleration, is turned on, fuel consumption increases drastically and the ability to maneuver or to aim weapons becomes almost nil. In fact, great speed in fighters, once a design goal, has become a by-product of design. More important is a plane's ability to accelerate through the usable speed range of 600 to 900 miles per hour. Although an aircraft's "Mach number" is still gushed over in some congressional appropriations hearings and newspaper stories, since the late 1960s the top speeds of U.S. aircraft have been falling steadily. The U.S. fighters designed in the 1970s—the F-16, the F-18, and the F-20—cannot fly as fast as standard fighters of the late 1950s could.

The F-16 and the F-20 have the same maneuvering limit: nine times the force of gravity, or nine g. The F-20 can turn slightly faster than the F-16 can; the F-16 can sustain a tightening turn for slightly longer periods than the F-20 can. Both planes can be used either as fighters or as tactical bombers.

The F-16 has a better cannon than the F-20 and can carry several more bombs. It is equipped with special communications "data links" and a built-in electronic jamming system, which the F-20 lacks. It also has the wiring necessary for a pilot to "consent" to drop a nuclear bomb.

The F-16 is also superior to the F-20 in range, although the difference—15 percent more range for high-altitude missions and 10 percent more at low altitude—is not great. The primary mission of U.S. fighters is the defense of Western Europe, where pilots would have to fly relatively short distances to join the fight.

Projections based on more than 600 flights show the F-20 to be superior to the frontline planes in the number of hours and crew members needed for maintenance. According to Air Force figures, the plane's mean number of flight hours between failures is 4.2, in contrast to 3.2 hours for the F-16 and 1.6 hours for the F-15. The mean number of man-hours of routine maintenance required for an hour of F-20 flight is fifteen; the F-16 requires thirty to thirty-five hours of maintenance per flight hour, and the F-15 nearly fifty hours. The F-20's greater reliability not only means that the budget for spare parts would be smaller and the odds that the plane would be ready to fly greater; it also means that fewer technicians and well-stocked hangars would be needed—expenses that are not included in

a plane's base price. Northrop estimates that a unit of twenty-four F-20s could be kept flying by 164 people; a unit of F-16s requires 323 people, and a unit of F-15s, 476. The F-20's favorable maintenance requirements and lower fuel consumption (a result of the plane's small size) yield a dramatically lower cost per flight hour. The F-20, Northrop says, costs \$1,304 an hour to fly, whereas the F-16 costs \$3,061.

The F-20 itself sells for \$11.4 million; the F-16, according to President Reagan's current budget request, costs \$19 million.



PILOTS AND ENGINEERS SOMETIMES MARVEL THAT the L-1011 jumbo jet, widely regarded as one of the best-designed aircraft ever, and the C-5 Galaxy transport, surely one of the worst, could have come from the same company—Lockheed. But in many respects they are similar planes. Both are large transports; they fly about the same distance at the same speeds; they use the same type of runway; neither is armed; they were designed in the same period. Yet the L-1011 has proved far more reliable than the C-5, costs less than half as much, and its wings haven't cracked. (The new wings built to correct that flaw in the C-5 cost a total of \$1.5 billion for just seventy-seven planes.) Lockheed designed the L-1011 to succeed in the marketplace; it developed the C-5 on a sole-source basis to military specifications.

To get the Pentagon's projects under way, committees pound out page after page of requirements and restrictions to which contractors are expected to respond in minute detail. In 1981, for instance, the Army sent potential contractors its specifications for a new observation helicopter. In reply it received 2.8 *tons* of documents—more than the helicopter itself was supposed to weigh. One proposal was 650,000 pages long. The paperwork is not limited to a contract's proposal stage, of course. Military projects are usually overseen by colonels, generals, and admirals to whom corporate designers cannot speak directly for clarification. Instead, memos are passed to and fro. The most dreaded of these is the "change order," in which the Pentagon, having asked for one thing, asks for something different—the staff of the office that issued the first specifications having had little or nothing to do in the meantime but think up ways to alter them.

Northrop's independence seems to account for most of the F-20's advantages over Air Force planes. General Thomas A. Baker recently told Congress, in one of the Air Force's few public statements on the F-20, that Northrop's construction strategy "differed considerably from the way any other [military] airplane has been developed." When Northrop's chairman, Thomas V. Jones, started the F-20

project, he sent designers a one-page memo listing approximate cost and performance goals, which they were advised to meet as they saw fit. The company built a \$24 million F-20 "production-development center"—a building where designers, engineers, and manufacturing supervisors worked side by side. Prototypes were constructed on the floor of a small factory inside the center, in the presence of the plane's designers. According to C. Robert Gates, Northrop's F-20 program manager, "That cut the loop down to zero. If something in the design was wrong or didn't translate into efficient manufacture, you could tell the proper person right away, because he was standing there." Under military-contract regulations it can take weeks or months of memo-launching to get word of a design defect to the proper desk—though sometimes word doesn't travel at all, as the C-5's wings attest.

Working outside the Pentagon's control, Northrop was able to choose components according to its own priorities, and in the competitions it held for subcontractors it was able to rate performance, cost, and reliability as equal rather than in descending order. Westinghouse, which builds the F-16's radar (also used on the B-1 bomber), offered to make a version of that system for the F-20, but the most it would promise was 100 hours between failures; for the system Northrop eventually chose, the figure was 200 hours. Once subcontractors were selected, Northrop stayed in close contact with them, to make sure they would deliver on their promises. An official at Northrop, Frederick Corey, says, "Some of the subcontractors were surprised. They just weren't used to working closely with the customer."

As the aircraft was being designed, the factory that would build it was designed too. According to Les Daly, a vice-president of Northrop and the company's spokesman, "Building the factory correctly is as important to the customer as building the product correctly." Northrop was aided here by the fact that it was the owner of the factory. Many weapons are built in government-owned contractor-operated (GOCO) factories, whose engineers have less incentive to come up with innovative production techniques. The F-16 and the F-14 are among the fighters built in GOCO plants. The M1 tank, the Maverick missile, and other weapons are also built in GOCO plants; most of the B-1 bomber will be. The Sparrow, Patriot, and Hawk missiles, among others, are the inventions of GOCO laboratories.

Knowing that any money saved in building the factory would mean lower costs and higher profits, Northrop looked for existing manufacturing equipment that could be converted to the F-20's production, rather than custom-designing what it needed, as is commonly done in GOCO facilities. The deep freezer in which Northrop stores its graphite-composite stocks before processing them was adapted from one used by the Kitchens of Sara Lee baking company. The graphite is sectioned by Gerber cutters—cloth-cutting machines popular in the garment industry. When Northrop decided to use injected-molded fiber

glass for some small parts, it consulted a leader in manufacturing of this kind: Mattel Toys.

If these management ideas sound familiar—engineers and assembly lines under one roof, close coordination with suppliers, emphasis on perfecting the factory itself—it is because they have been much discussed of late. They are prime tenets of Japanese management, especially in the automobile industry. Northrop officials cringe at the comparison, but it is unavoidable. In the 1960s, when the Japanese looked at the American car market, they saw that what was missing was a small, highly reliable car, and they changed their factories altogether to make such a car at a competitive price. Northrop officials say simply that the F-20 turned out to be so cheap and easy to service because it was developed privately. “Maintainability must be designed in at the outset. If you try to add it on later, you’re lost,” Gates, the F-20 program manager, says.

Northrop is offering to sell the F-20 with a contract that guarantees a fixed cost per flight hour for spare parts; the company says that it can do so only because it wholly controlled the F-20’s design and knows for sure how well all the pieces of the plane work. The offer has met with considerable skepticism in the aerospace community, in part because of the genius that defense contractors traditionally have shown in escaping apparently ironclad guarantees. But the reaction also reflects the nervousness of other defense contractors, who fear the precedent that will be set if Northrop ever sells the F-20 and lives up to its bargain. Last fall Congress passed a weapons-procurement “warranty” bill, which the Pentagon has since done its best to circumvent. Some defense analysts think that the terms imposed by the weapons-warranty bill are so broad that no contractor, even the most public-spirited, can reasonably meet them. If that’s the case, a fixed-price parts contract might be a workable alternative.

RECENTLY THE AIR FORCE SYSTEMS COMMAND MADE a film to show to defense contractors. The film begins with the Indianapolis race-car driver Rick Mears praising the designers of his car, which can jack itself up in order to make changing tires during pit stops easier. There are racing scenes, and throbbing electronic music plays. Then General Robert T. Marsh, the head of the Systems Command, appears on the screen. He asks that future Air Force planes be produced like the race car, with maintenance features built in.

“It makes no sense at all for us to build and deploy highly capable weapons systems if a combat commander can’t rely on them because maintenance requirements are too complicated and too frequent,” General Marsh says in the film. Marsh goes on to explain that the Air Force historically has considered its bases “sanctuaries,” immune to attack, where complicated and time-consuming repair jobs can be conducted without interruptions. By 1943 the English and North African fields from which the Allied Forces bombed targets in Europe were rarely bombed them-

selves, and were also secure from ground attack. During the Korean and Vietnam wars attacks on Air Force bases were equally rare; many planes used in Vietnam were operated from sanctuaries on Guam or in the Philippines. Marsh notes that the secure air base no longer exists in Europe. “We must now institutionalize this emphasis [reliability] and ensure that we pay as much attention to how available a new weapons system is as we do to how fast it flies, how much it carries, or how much it costs.”

Then the scene shifts to one of NATO’s air bases, where General Billy M. Minter, the commander of the U.S. Air Force in Europe, stands before an A-10, the most reliable American combat plane flying today. General Minter declares that if chemical or nuclear weapons were employed in a future war, many planes left undamaged by those weapons would still be destroyed in effect, because ground crews dressed in biological protection suits, which are about as cumbersome as deep-sea diving gear, would not be able to repair them. He points out that for a squadron of F-15s even “a slight increase in the [mean time between failures] would allow us a reduction of fifty [maintenance] people and maybe \$15 million worth of avionics intermediate-station equipment.” Then General Marsh returns to add that “supportability, reliability, maintainability, flexibility, and serviceability” are “the elements that actually determine just how good our new weapons systems are as war-fighting tools.” Marsh and Minter, both four-star generals near the top of the Air Force’s pyramid, speak as though what they are saying will come as news to their audience.

ALTHOUGH THE F-20 IS THE FIRST PRIVATELY DESIGNED combat aircraft in many years, it is not the first ever. One of the most important planes in the Air Force’s history—the P-51 Mustang, widely acclaimed as the decisive fighter of the Second World War—was built by the North American Aviation Company (now Rockwell International) with no military sponsorship. At first the P-51 met the same reception that the F-20 has: the Air Force, which was then part of the Army, refused to buy it. Those who know that the P-51 appeared in Europe in 1944 might be surprised to learn that the plane was available, but unwanted, in 1941. The Army Air Force favored the P-38 Lightning—a plane much larger, less maneuverable, harder to fly, and easier to shoot down than the P-51. It also cost two and a half times as much.

The Army Air Force resisted the P-51 primarily because it was invented by others, a prejudice that afflicts all bureaucracies, but military bureaucracies especially. The Browning automatic rifle, which in the Second World War became the infantryman’s favorite weapon, was developed in the 1930s by a private designer and was adamantly resisted by the Army’s ordnance hierarchy. Around the turn of the century the Navy steadfastly resisted a privately developed sighting system that substantially improved the accuracy of naval guns. Some admirals actually insisted

that hard-to-aim guns were *good*, because they forced a warship to pull alongside its target and do battle in the traditional point-blank style.

The same not-invented-here syndrome appears to be a strong factor in the Air Force's reaction to the F-20. When General Thomas Baker was asked at a congressional hearing why his service was not interested in the airplane, he replied, "Because it was not designed according to U.S. Air Force requirements"—not that the plane couldn't *satisfy* those requirements, but simply that it was not designed in response to them.

At the moment, Northrop has few prospects of export orders large enough to justify opening a production line. Since Carter announced his policy of restricting sales of frontline aircraft, a policy nominally endorsed by the Reagan Administration, nearly every country that has requested an exemption from the restriction has been granted one. No fewer than 1,160 U.S. frontline planes have been shipped to foreign countries: 377 during Carter's term of office and 783 since Reagan was elected. A total of eight FX-class planes—the General Dynamics F-16/79—are on order by Singapore, but even that tiny country has said that what it really wants is frontline equipment.

Technological glamour and political prestige drive the market. Congressman Mervyn Dymally, of California, a native of Trinidad who has spent a considerable amount of time in Venezuela, recently said of Venezuela's purchase of twenty-four F-16s, "They want what's best. It doesn't matter if it works." Foreign buyers follow the lead of the U.S. Air Force—and if the U.S. Air Force doesn't care about reliability, why should they? The leaders of demo-

cratic states like the NATO countries put themselves at less political risk if they advocate an Air Force plane (if something goes wrong, they can blame Washington) than if they encourage an unorthodox purchase that will be hard to explain to voters and easy for political opponents to criticize. In an authoritarian state like Pakistan the desire for prestige and an image of might—however much might forty airplanes of any type can provide—are the important factors.

The buyer seldom pays the full cost. Mark Thompson, a reporter for the *Fort Worth Star-Telegram*, has found that more than half of the \$8.1 billion cost of foreign sales of the F-16 has in fact been paid by the U.S. Treasury, in the form of either outright grants or subsidized loans that later are quietly forgiven.

Israel is a case in point. As a state at war, and one that often modifies U.S. weapons to make them suit the conditions of war, it of all countries ought to be attracted to the F-20. However, Israel has shown no interest in the airplane and continues to acquire the more expensive F-16. This would seem to be an open-and-shut argument against



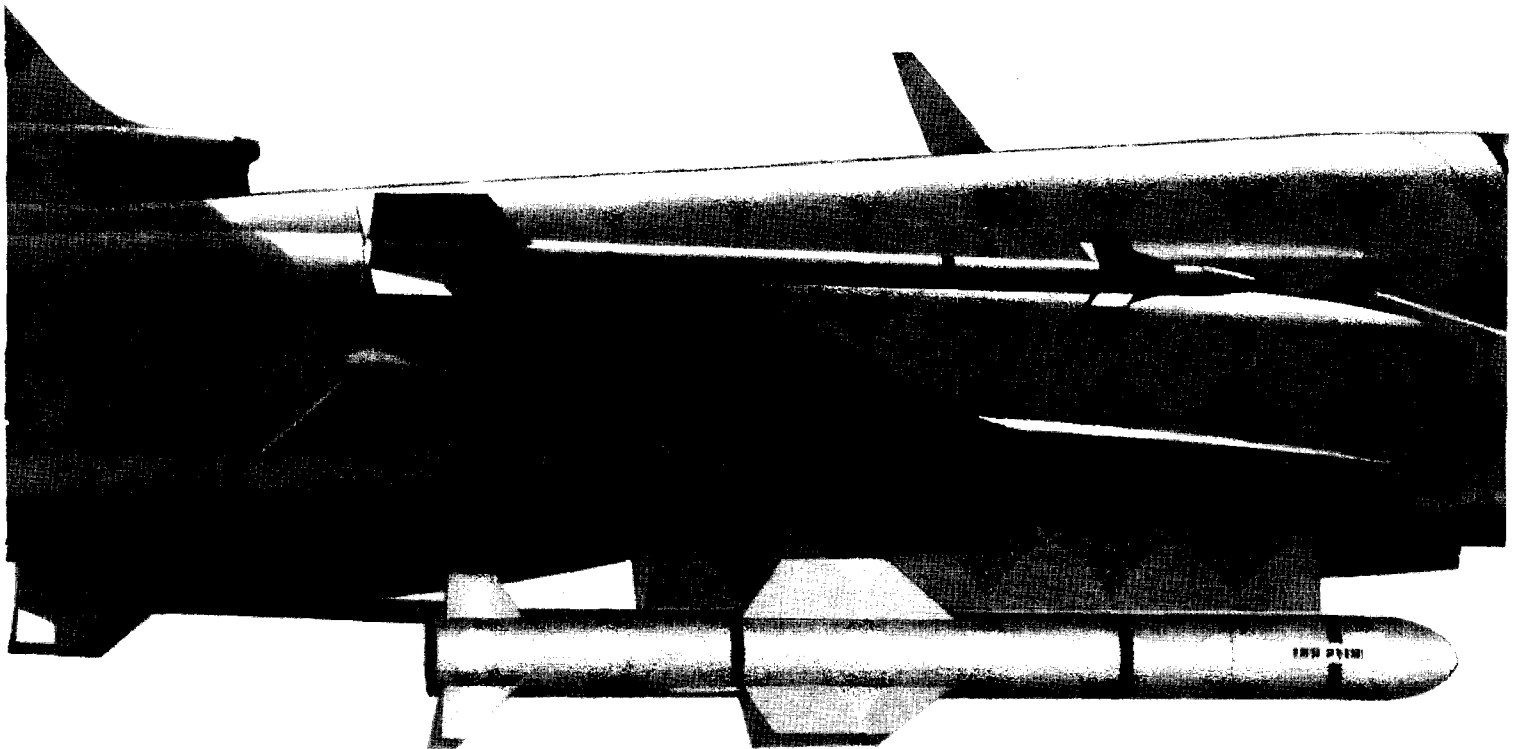
the F-20. But for Israel cost is not a factor. Israel receives more aid from the United States than any other country does. One hundred and fifty F-16s, worth \$3.3 billion, have been shipped there since the plane went into production, and Israel has paid only \$22 million for them—about the price of a single plane. If Israel asked for F-20s instead, it would save somebody else's money. Indeed, Israel would in effect be asking Congress to lower its foreign-aid appropriations, which would be a geopolitical first. In addition, by requesting a privately developed plane, Israel might offend the U.S. Air Force, with which it has a vital interest in maintaining good relations. The Air Force not only supplies Israel with spare parts and reserve materiel but also, should the worst occur, might be Israel's last hope.

The cycle in which the United States pays for weapons that its clients cannot use continues. General Dynamics has asked for permission to scrap its FX-class plane altogether and have its current series of the F-16—which at present outnumber any other fighter in the Air Force—classified as an FX fighter for export. (The logic is that since a new F-16-C series is being designed, the current F-16-A is no longer frontline.) Secretary of Defense Caspar Weinberger recently told Congress that mounting debts from weapons purchases are pushing Third World countries toward bankruptcy. "Many of the countries in financial trouble are strategically important to the United States, and we must devise solutions to enable them to continue to provide for their security," Weinberger said. The solution he favors is increased tax subsidies to cover the loans. The idea of switching to less expensive weapons was never mentioned.

AT ANOTHER HEARING, IN MARCH, GENERAL CHARLES Gabriel, the chief of staff of the Air Force, said in reference to the F-20, "We've been with the program all along and we've been flying it and what [Northrop is] doing out there is the best I've ever seen." The comment is surprising, given the attitude toward the F-20 that other Air Force officers seem to have. I tried to reach Gabriel to ask him to elaborate; an Air Force spokesman said that the General's statements "stand for themselves" and that neither Gabriel nor the Air Force would have further comments. General Thomas Baker, who was introduced to the House Foreign Affairs Committee as "FX program manager," also refused to be interviewed. His spokesman, Colonel Thomas Cooper, told me, "General Baker can't possibly have anything to say about the F-20, because he doesn't know anything about it." (Baker, a pilot, has *flown* the F-20.) Cooper said, "There's no way we're going to let you ask us about this." Even General Richard Abel, the Air Force's director of public affairs—the man whose job it is to communicate with the press—declined to talk about the F-20.

Of course, the Air Force could simply steal Northrop's ideas. There would be little cause to shed tears for Northrop, which last year enjoyed \$846 million in Pentagon business. Copying the best features of the F-20 is not the plan, however.

The plan is to continue building the F-15 and to step up production of the F-16 well into the 1990s, adding the AM-RAAM missile and perhaps stealth features to both. If more fighters like the F-16 are needed—as evidenced by the Air Force's intention to buy hundreds more—that same need



could be met at a lower price by the F-20, which would not require the addition of stealth features, because its small size is itself radar-evasive. Buying F-20s is not on the Air Force's agenda, however. F-15s and F-16s are scheduled to be equipped two years from now with new engines that will be more reliable than the F100s but will retain the thrust-at-all-costs design goal. The F-15 has been assigned a new mission to justify its continued production: long-distance tactical bombing, which the Pentagon calls "deep strike." Although the F-15 was developed to be a high-altitude, supersonic missile-launcher, it will be employed as a low-altitude, subsonic bomb-dropper. The deep-strike F-15 will have no fewer than seven computer screens for its two-member crew to watch.

The Air Force has new fighter designs in the works, although none can be in production until the end of the decade, when most of the F-15s and F-16s expected will have been delivered. Two prototypes—the F-19 and the X-29—are being tested. The F-19 is a small fighter designed for maximum stealth; the X-29 has futuristic "forward-swept" wings for maximum cornering power. These planes are generally viewed as research projects, not as forerunners of production aircraft. Also in the early stages of development is an "advanced tactical fighter" (ATF).

The real object of the Air Force's affections may be grander flying machines than any of these: spaceplanes. Getting military pilots into space is a goal that dates back to the Air Force's experiments with the X-15 rocket plane in the 1950s. Stanley A. Tremaine, the deputy for development planning in the Air Force's Aeronautical Systems Division, says that he expects that the ATF will be the last fighter the Air Force will ever build that is confined to the earth's atmosphere. At Wright-Patterson Air Force Base, in Ohio, engineers are studying proposals for "trans-atmospheric vehicles" with engines powered by liquid hydrogen, similar to those on the space shuttle. These craft would blast off on rockets from a runway, fly into space, re-enter the atmosphere, and glide back to an airfield. Space cruisers, which the Defense Advanced Research Projects Agency (DARPA) is designing, look roughly like Mercury capsules and carry one or two crew members. They would be launched into space on rockets, release a "cargo," re-enter, and land suspended from parachutes.

Although one can safely assume that the cost of spaceplane fighters will be breathtaking, there is little indication of what they will *do*. DARPA's "space cruiser" is billed as a "research vehicle," but after the Mercury, Gemini, and Apollo programs more research into capsule construction is hardly an urgent need. The space cruiser's cargo probably would be an anti-satellite or anti-missile weapon of some kind, but why such a weapon should be toted by an expensive manned capsule, instead of being remote-controlled, is a mystery. Similarly, what a transatmospheric fighter might shoot in space that could not be shot as easily by unmanned weapons is hard to imagine. And once such a fighter re-entered the atmosphere, it would be at the

mercy of ordinary endoatmospheric fighters of all descriptions, just as the space shuttle is at the mercy of any pilot who might care to shoot it down. But given Reagan's enthusiasm for space weapons no matter how uncertain their purpose or practicality might be, and given the Air Force's perception that as long as Reagan stays in office no price is too high, small wonder that a light conventional fighter like the F-20 evokes no interest.

GENERAL DYNAMICS, THE BUILDER OF THE F-16, IS the nation's largest defense contractor and also one of the best-protected in Congress. The company builds its fighter planes in Texas, the home state of John Tower, who is the chairman of the Senate Armed Services Committee. The F-16 factory is in the district of House Majority Leader Jim Wright. Northrop has its connections too, of course. Jones, its chairman, is said to have the ear of the White House. He has pushed for something to be done about his unsold plane, and the White House has in turn pressured the State Department and the Air Force to start talking up the F-20 overseas. But the real question is not why we aren't trying harder to sell the F-20; it is why we aren't keeping it for ourselves.

Northrop has never dared to suggest publicly that the Air Force should buy the F-20, and company officials dismiss the idea even in private, saying that nothing can possibly come of it, for bureaucratic reasons. Northrop also does not dare to push too hard, because the Air Force holds a trump card in the form of the Stealth bomber contract, which is potentially worth billions more than the F-20. In 1982 the Boeing Company became outraged that the Air Force was buying still more of the C-5 Galaxy, despite the C-5's terrible record and despite the fact that a cargo version of the Boeing 747 would have cost less than half as much. Boeing broke a long-standing gentlemen's agreement: it placed newspaper ads criticizing the C-5 and complained on Capitol Hill that the fix was in. The effort went nowhere, and a few months later the Air Force had its revenge, canceling without warning Boeing's contract for the air-launched cruise missile. The message has not been lost on other defense contractors.

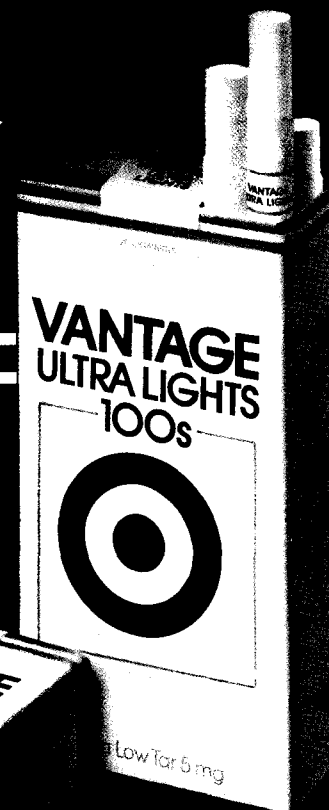
There is one way to overcome the Air Force's institutional prejudice against an airplane that was developed somewhere else and doesn't cost enough: through the leadership of the President and the Secretary of Defense. So far, neither has shown any willingness to challenge the way the Pentagon does business. Michael Burch, Weinberger's press officer, told me that Weinberger has not considered talking to the Air Force about the F-20 and does not intend to consider it. "We don't have any authority over what weapons they should or shouldn't have; all we do is review their budget requests," he said. This is an astonishing interpretation of the United States Constitution: that the Secretary of Defense has no control over the Air Force. At the moment, however, it would be hard to dispute. □



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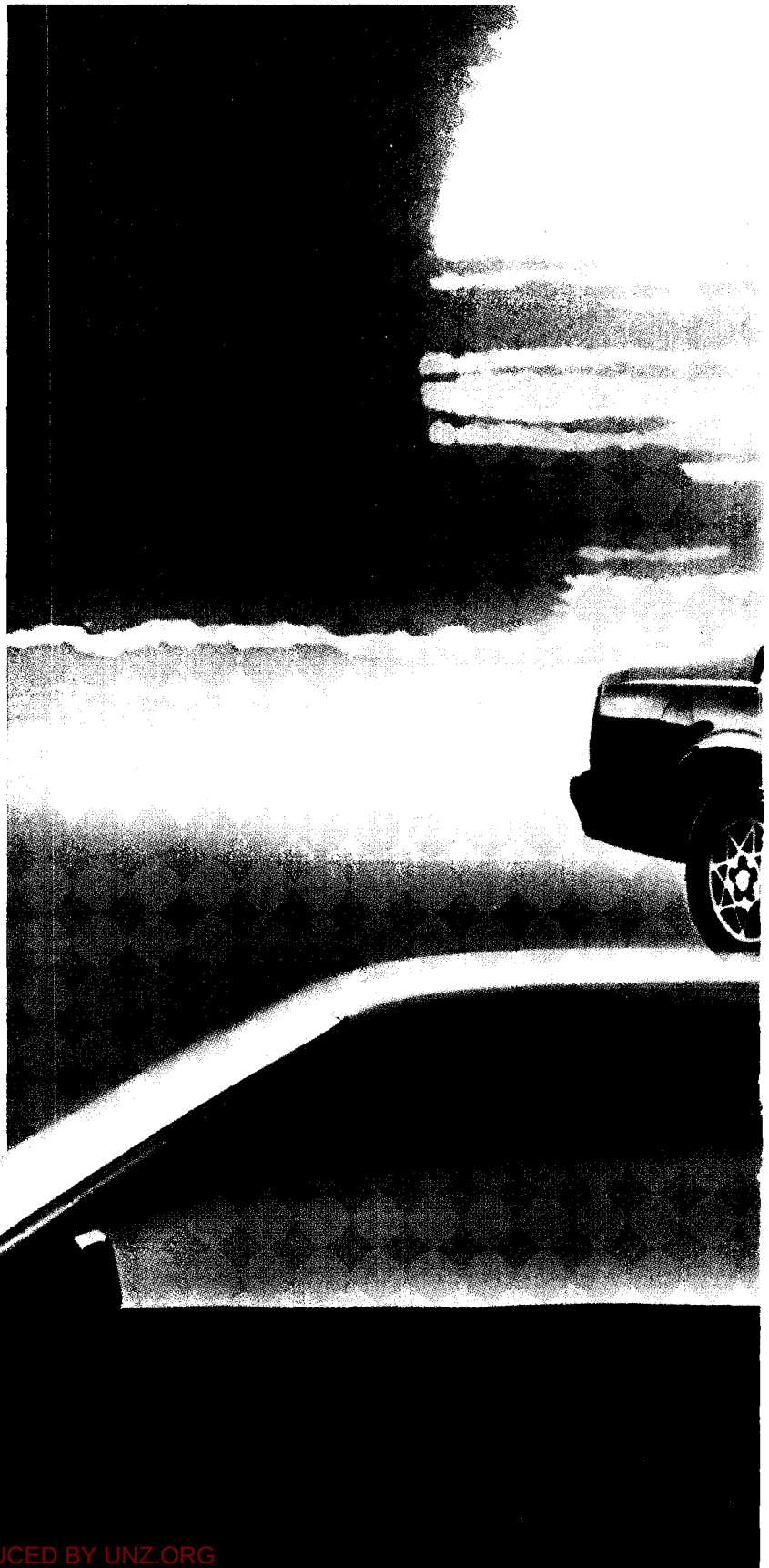
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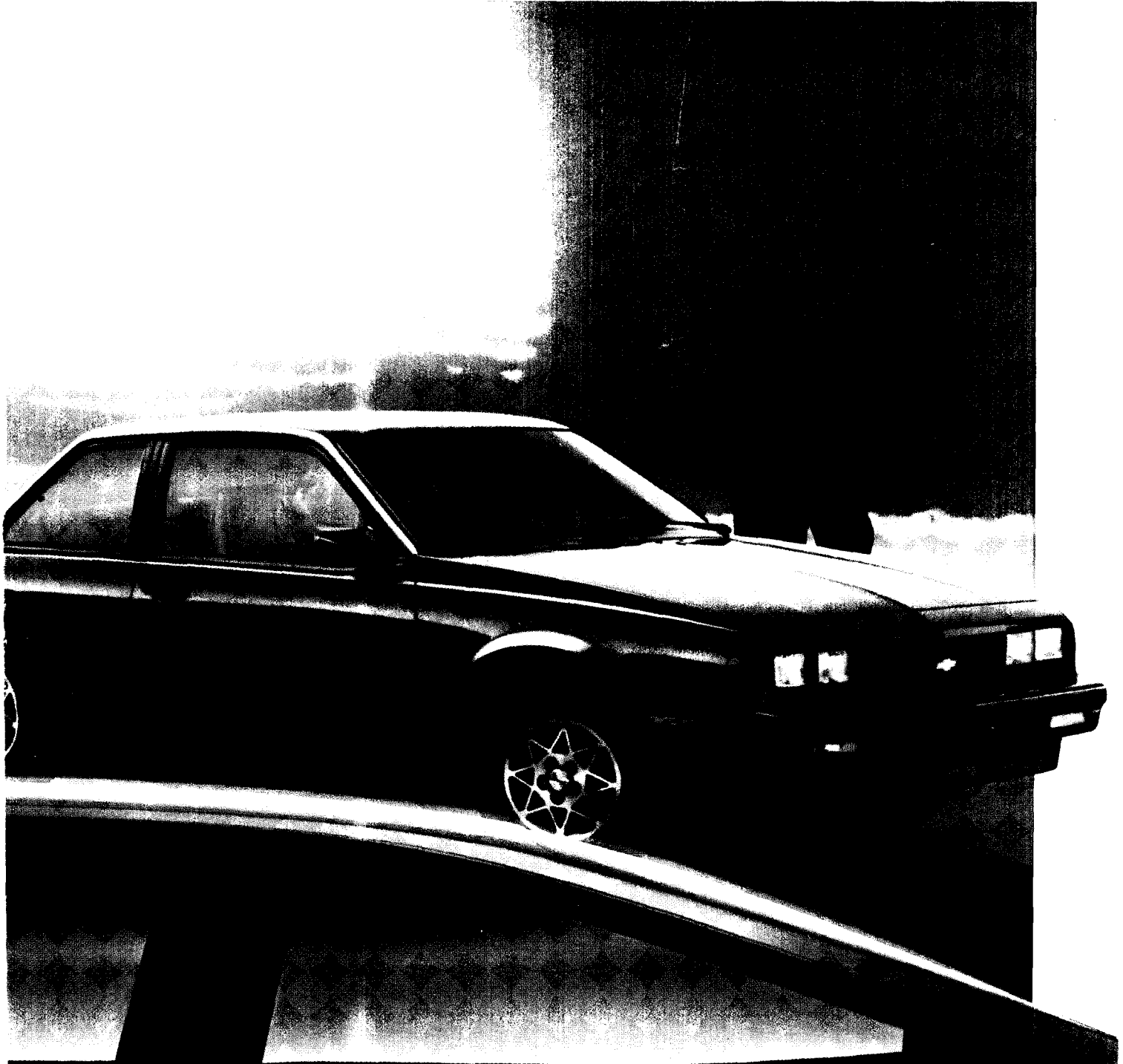
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A Short Story



FIRE BLIGHT

BY JOYCE KORNBLATT

WHEN I WAS A CHILD, MY FATHER DROPPED OFF A bridge in full view of my mother and me, and disappeared forever into the Shenandoah. This happened in Harpers Ferry, where the three of us had gone for a Sunday excursion. Afterward, I would hear her describe the way he had plunged into the water to save a drowning boy, and had perished himself.

"Mama," I'd say, "why don't you tell the truth about my daddy?"

She would fix her glare on me. "What do you know about truth? You were only five years old. You were a baby. What could a baby remember anyhow?"

Everything, I'd think. More than I care to.

Mama preferred denial and invention. In Berkeley Springs, West Virginia, she raised me in a farmhouse two miles down the road from the Lodge, where she worked. She gave massages to the people who came there for the famous mineral baths—they still do. George Washington had visited there, and Mama talked as if she, Esther Scruggs Temple, had helped him down into the healing water. "George Washington," she'd announce, "put us on the map." This from a woman who worked for an hourly wage, collected tips in her pocket like a waitress or worse, and came home exhausted every day to soak her hands in a solution she made from Epsom salts. Her joints hurt so from all those hours she kneaded backs and shoulders, soothing the aches and pains of well-off ladies from D.C. or Charleston. Mama crowed about George Washington as if she were the proprietress of the establishment. It gave her a sense of dignity that the work itself did not provide. It gave her a place in history by association. But then she would go on about how he had this lumbago and all, and how he would come to Berkeley Springs with this assistant or that, but never with Martha—"It appears they didn't get on so well," she would confide—and even what he had eaten for breakfast, lunch, and supper during his stay.

He did come, true, but I don't think the Lodge was even there at the time. That part she made up entirely, just as she'd fabricated her story about my father's death.

Finally, when she was old, she said, "He put up a good front. Window dressing."

Here I had pressed her all these years for explanations,

reasons, a truth in which my sorrow could retire. She gave me harsher news than I wanted.

"That's your opinion," I said. "I think it was the fire blight."

Daddy raised Rome Beauties, winesaps, and McIntosh. While he was alive, my mother sold the fruit from a roadside stand she operated in front of our house. She sold cider she pressed herself, filled gallon jugs with a siphon from the vat that rested on the newspaper-covered wooden floor in the kitchen. I remember the smell of that tart perfume the way another person remembers her mother's cologne. Off-season, Daddy drove a backhoe for a builder in town and did carpentry jobs for neighbors, but if you asked him what his work was, he would tell you, "I have the finest orchard in Morgan County."

"Think what you like," Mama said. She shut her eyes. "It's all water over the dam."

If so, I'm still swimming in those white-frothed currents.

MAMA AND I ARE ON THE FRONT PORCH, SHELLING peas. It's mid-April, dogwoods and azaleas and all the spring bulbs ablaze.

"Fire blight," Daddy says.

When she sees him standing there with that blackened branch, the pods in Mama's lap clatter across the weathered floor. She is on her feet that fast.

"All my McIntosh have it," he says. He sinks down on the bottom porch step, his forehead to his knees, his shoulders quaking as if he were chilled, as if *he* were sick, rather than his trees. I've never seen him sad before.

"A farmer's life is always risky," Mama says. She is still on the porch, and if she had a pulpit in front of her, she could pass for a lady preacher. Her arms are stretched out wide, and one of them pushes me back toward the glider when I make a move for the steps. "Nature does not promise us—"

"Damn it, Esther!" He cracks the branch in two across his knee and heaves the pieces into the yard. Withered blossoms scatter like ash over the lawn. This action empowers him again. He's on his feet, full height. "If I wanted an agriculture lecture, I'd call up the extension service!" He stomps off for the road, which I'm not allowed to cross. The orchard's on the other side. At the front yard's

Joyce Kornblatt is the author of *Nothing to Do With Love*. She teaches writing and literature at the University of Maryland.

edge he turns around. "Don't you know how to give a little comfort to a man?"

Mama's arms collapse. Her mouth gapes, but no sound comes out, just air. She looks the way a fish does when it's caught. She forgets about me and charges into the house, pea pods squashed beneath her stride. Through the screen door I hear her clomping up the stairs, and then the door to their bedroom slams, and who is left to comfort him but me?

It seems I fly the span from porch to orchard, avoiding altogether that deliberate and forbidden trek I must have made through the grass and over that graveled road, where cars and trucks and tractors pass our property all day long. I am in that grove, is all I know. Up and down the dappled paths that run the length of the orchard, I hunt for him. I'm halfway along a blighted row—those trees look as if they had been in a fire, yet nothing is burned away—when I see him straddling a high limb, his arms hugging the ruined bark. "Daddy!" I call to him. Before he can right himself, I have started up the ladder. Each rung's a whole leg-span for me, but I am climbing as if my feet had springs in them, and fear is no greater than a tickle in my throat.

"Rosie, good Christ, how—? Now watch yourself, be careful—"

He does not order me down. He's glad I've come. He guides me up, up to where he is, hoists me from ladder to branch, and when I'm there beside him on that perch, his arm holding me secure, it isn't fire blight I see this close to the sky but dazzle. In that shining realm we sit together for a while. Then he carries me down, into the shadows again, and home.

LIKE MAMA, MY HUSBAND, WENDELL, DID NOT LIKE me to talk about Daddy's suicide. "I try to leave violence at the office," he would tell me. "I can't come home to yet another grim tale, Rose." By "the office" he meant the FBI building in Washington, D.C. Wendell worked in fingerprints for thirty-odd years. He never could rid his nails of the residue collected there like coal-mine grime, like furnace soot. Months would pass. I'd keep my silence. Memory shoved up under my heart, pressing against my ribs, shooting pain down a leg, up my back to my shoulder blades, sometimes straight to my head. Migraines, I called those attacks, when really the cause was Daddy, poised on my brain as if on the ledge from which he'd jumped. If the pain struck on a weekend, Wendell would sit beside me on the bed in our darkened room, our boys banished to the park or the movies or a neighbor's apartment, and he would lay cool washcloths over my throbbing eyes. So long as the pain was in my body, Wendell nursed me with sweet patience. But let me call out for my father in the middle of the night, and Wendell would shake me awake, his voice rough and insistent: "That's *enough* now, Rose. You're having a *nightmare*." He said it as if I had burned dinner or lost my keys. As if he

were pointing out some lapse on my part. Some failure. "It's Daddy," I'd say, locked on his image there by the bureau, there by the clothes hamper, now there by the closet door. Wendell would snap on the light. "Don't go stirring up morbid memories," he'd say. "Stop dwelling in the past." When women marry, we are supposed to drop our girlhoods behind us like so much extra freight and call ourselves Mrs. Whoever and bob our hair. The past wiggles away like half of a severed worm. Miracle or mutilation, which is it? Well, what did that mean, after all—"dwelling in the past"—but being at home in your own life?

That day comes back to me all on its own, like weather, like the sunny day it was, June 5, 1923. Sometimes I wonder what would have happened if it had rained, if we hadn't driven for hours, my parents and me, into the Blue Ridge Mountains, and parked behind the train station where John Brown let through that conductor who sent the troops right back to capture him. What if we had stayed in our farmhouse on Winchester Grade Road and played checkers?—the way we did on dreary days when the rain pelted the tin roof and kerosene lamps burned in every room. It is hard to think of suicide as an urge that comes on you like a passing itch, nothing major, which, if you leave it alone, will give up and stop pestering you by the time you're ready for bed. Hard to think that, but even harder to believe that death had such an urgent claim on someone who wore happiness like a custom-made suit. John Temple was all strut and swagger; you would have thought they'd have to drag him off this earth, not that he'd decide to leave it at the age of thirty-one.

That morning, almost two months since I had climbed the tree to comfort him, Daddy and Mama packed the picnic basket with hard-cooked eggs, ham sandwiches, pickles, and strawberries from the patch by the back door. Daddy gathered up the newspaper and laid it across the food. Mama folded the quilt from my bed and gave it to me to carry. She was in charge of the mesh sack into which she had put bug-bite ointment, a rubber ball, a deck of cards, her needlepoint project, and three visors we could use if the sun began to bother our eyes. At seven we got into our Ford. We sat three abreast, me by the window, and rode from one mountain range to another. The earth seemed to have no flat places on it, only ascent and descent; balance seemed not to come easy anywhere in the world. We braced ourselves against the jostling. I pressed my feet up against the dashboard. Mama held onto Daddy's sleeve and mine. He wedged his shoulder into the corner made by the seat and the door. Daddy and Mama talked to each other most of the way, and I liked the sound of their voices that morning, even though sometimes at home their talk shut me out and I was lonely in their midst. Maybe that came from being the child. Or maybe my father's unhappiness was in our house all along, living under his words like rocks beneath the water's surface. Maybe Mama was right: he put up a good front, and the fire blight was not the beginning of his troubles at all. I do admit that sometimes the sound of them talking to each

other at home encircled them like an electrified fence: *Keep out*, it said. *Dangerous to children*.

But not that morning, not in the car. Maybe because we were all pressed up against each other, connected one to the other almost like one body. I don't know.

WHEN WE PUT ON THE VISORS, MY MOTHER SAID, "We look like card sharks. Who's for gin rummy?"

She was fishing in the mesh bag for the deck of cards, while I helped my father spread the quilt on the grass. Up and down the riverbank I saw sets of parents and children readying their own picnics. No matter that behind us lay the site of a bloody Civil War battle and several murderous floods, and in front of us the river twisted over sharp rocks and storm-felled trees, their roots, upended, like claws sticking out of the water.

Mama said, "Here's your hand, John."

On my knees I watched him play.

"Rosie," Daddy said. That was his name for me, and I've never allowed anyone else, not even Wendell, to use it. "Rosie, you are the best luck this small-time gambler ever had." He rubbed my elbow as if I were one of those amulets betting people carry in their pockets and he had everything he owned on this game. He had a look in his eyes that said, "I need magic, Rosie. I need good fortune bad." I smiled hard; I held my breath and clenched my fingers and toes and made a low growling sound in my throat for him; but Mama called "Gin!" the third time she picked a card from the pile and Daddy lost his nickel and his grin and his good posture all at once.

Mama said, "Now, John, it's just a game," and reached out to tweak him. But he flinched, stood up as though a bee were after him, and walked off huffy and shamed. I watched him get smaller and smaller until he was just a slash of blue—he was wearing blue overalls. I watched him move past where the last clump of people sat, down to the place where the bridge pilings were. From where I was, they looked like toothpicks: the bridge that arched over Mama and me looked as though it were holding itself aloft, floating, not attached to anything.

Mama said, "Well, Rose, let's eat our lunch."

She said it in a strange way, as if there were only two of us.

"When Daddy comes back," I insisted.

But she was taking the food out of the basket, placing it on the blanket. She was holding her head at an angle of reproach toward me or Daddy, I couldn't be sure which.

I wanted to run over the grass to where he was and lead him back. I scanned every inch from the blanket to the pilings to the last family in sight. But I couldn't locate that blue form anywhere.

Right then I realized that others were searching too. Or at least they seemed to be. Heads craned all along the grass. Hand after hand pointed upward, and voices rose in a single web of sound, a hummed "ooooooooohhhhh" that lift-

ed to the level of the bridge and hovered there like a n in the fierce light of that distant afternoon.

"Mama," I said, "what—"

And then we saw him: too far to make out his features, too near to mistake him for any other man. My father, Daddy, John Temple, swinging a second leg over the railing and stepping off into the air, easy as if the ground were still beneath his feet, falling through the bright air like a bird zooming to earth. What I mean is, something about him seemed to be at home in flight, comfortable in his sudden descent, a winged creature's acrobatics, not a man's last plummet. I felt sure that my father would loop up right before impact, soar to the bridge, win everybody's dazed applause.

But Mama's scream was no cheer. Shriek, wail, cry of terror—I thought my head would burst from the sound of it. I had never heard a person make a noise like that, and I haven't since.

He glanced off rock, Daddy did, sank into the water's foam, and I never saw him again.

The rest of the day drowned with him. I have no recollection of what we did, who took us home. I'm blank on everything up until the moment when, four days later, his coffin was lowered into the earth, rain tapping like a child's knuckles on the wood, he not answering the little knocks, no, my daddy deaf to all appeals now, gone down into the final quiet, gone down now, gone.

AFTER DADDY DIED, MAMA JOINED UP WITH THE FAITH Evangelical Choir of the Daughters of Zion Pentecostal Church. She practiced her hymns around the house the way other ladies hummed "My Blue Heaven." Elsie Stitt, the first soprano, worked at the Lodge, and she told Mama she could get her a job there too, but first Mama had to be trained. We still had the house, but the orchard was up for sale, and Mama needed a way to earn us money. For weeks Elsie would come home with Mama from their choir practice and give her lessons on massage. This was after I'd been put to bed, but one night I couldn't sleep and padded into the parlor from my room upstairs. Mama was lying on the braided rug with nothing on but a towel over her privates, and Elsie was rubbing oil into Mama's legs. I said from the doorway, "If my daddy were here, you wouldn't do this."

Mama made a noise like barking. She bolted up and the towel dropped away. Lamplight fell on her oil-shined flesh and she looked for all the world like a stranded seal. "Well, your daddy's *dead*," she rasped. "And you know what he left me to raise you with? Eight hundred dollars in debts and a lapsed life-insurance policy, *that's* what."

She was crying now. I wanted to give her back her towel, but Elsie Stitt retrieved it first and handed it to Mama, and I ran upstairs to do my own crying in that pillow where I poured out my nightly grief.

I never said another word to Mama about her massage work, but I knew she didn't like it any more than I did.

She'd say things to me like "The body is merely the soul's temporary lodging, Rose." Yet she spent all day attending to the flesh she now dismissed. Herself, she let go. She quit making herself pretty, let her hair get stringy; her smooth skin became puckered and lined like a web, like the inside of an orange peel. This continued for nearly two years. Imagine.

Then she got herself a boyfriend: Mr. Homer Simpson, a just-widowed traveling salesman from Akron, Ohio, who passed through Berkeley Springs on business and decided to have himself a treatment at the Lodge. Homer Simpson looked very much like W. C. Fields. I used to imagine him cuddling up to Mama and whispering "My little chickadee" into her ear. He started courting her immediately. That very first night he bought her dinner in the dining room, and she came home with eight boxes of wood-handled steak knives (that was his line) and color in her cheeks that I hadn't seen since before Daddy died. You'd have thought Homer had given her underwear, the way she blushed showing me that cutlery. Three weeks later he moved himself down to Berkeley Springs and rented a room in a boardinghouse. Mama dropped out of the choir, started using a curling iron, and gave herself facials every other night with a mixture of eggs and lemons and mud that she dug up from a place under the downspout by the back door.

I couldn't say which I preferred, religion or romance. Both of them made her strange.

I still remember how things were when my father was alive. Begonias blooming on the windowsills, starched sheets, lattice-topped fruit pies cooling on a rack in the kitchen. "You don't make pies anymore," I told her a few months after the funeral.

She said, "All the pies in the world won't bring John Temple back to us." As if that were my notion. *I* was the one who was missing her care; she was gone a lot, first with the choir and then with Homer. She never married Homer. They "kept company" until she died. "We're in no rush," she'd say when people asked, which, as you can imagine, they did. "We're taking our time." What I think now is that she never got over seeing herself as Mrs. John Temple, so marrying Homer was not a real possibility for her. That is what I think, although we never did discuss it. This theory comes from losing a husband myself and hearing people call me a "widow" when I know I'm as married as ever, even if Wendell has "gone to his reward," as they put it.

I don't know where anyone goes when they die. I don't know where Daddy is, or Mama, or Wendell. Unlike my father, Wendell left me insurance money, and after his death, five years ago, I placed a call to Elton Howard, realtor, Berkeley Springs. I had been reading the classifieds under "Mountain Property for Sale," something I have

done daily for almost forty years, since I married Wendell Fry, left West Virginia, and came to live in an apartment building on upper Connecticut Avenue in Washington, D.C. Wendell never wanted a house. He said apartment living suited him fine, that he couldn't be bothered with upkeep. But I have always missed the sense of *roaming* I had as a girl. All my life I have wanted land, flowers that would put the National Arboretum to shame. My daddy was a gardener. I can close my eyes and smell the soil he's just upturned, see the startled worms burrowing back into the earth's dark depths. I have plotted out entire yards in my head: how I'd plant the azaleas, where I'd put the rows of daffodils and tulips and impatiens. I'd have lots of impatiens, pink and white and that blood-red color they have, blooming in the shade my cherry and magnolia trees would make. Once I figured out a whole Japanese garden, stone river and all, hyacinths sprouting along the edge of the imaginary water.

"My name is Rose Fry," I said to Elton Howard, "and I am interested in buying a house."

What did I have in mind to spend? he asked.

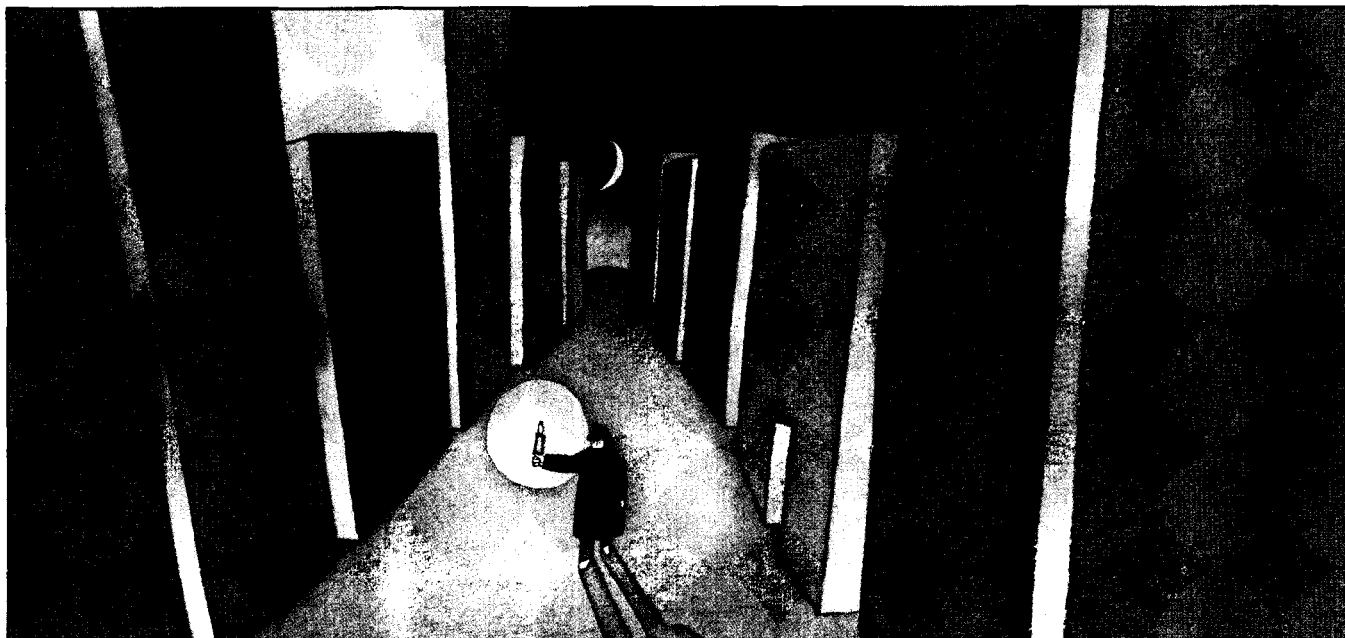
I told him.

"Mrs. Fry—I take it it's Mrs.—that wouldn't buy you more than a barn."

Five years ago I let that stop me, thanked him kindly, had myself a good cry, and walked a while outside, until the traffic din and bus fumes drove me in again. But last night I dreamed that I placed that call a second time. "I'd like to see what you have," I told Mr. Howard, and then I was there, in Berkeley Springs, buying myself two stories of weathered wood and windows taller than Wendell was, over six feet even at the end.

In my dream I have acres, some still wild, some cultivated, just the way my father did. I look out over the Cacapon River. On the opposite bank fluted rock cliffs rise like a tabernacle built right into the earth. In the morning I walk up to the pasture. The sun polishes everything—sky, mountains, river, grass, cliffs, even the faded-gray barn siding itself—to such a sheen that the world as I know it seems just a thin layer of brightness that could at any moment give way, like an eggshell or a crust of ice or a light bulb's fragile glass casing. A whole other world would then reveal itself to me.

I contemplate this a while. Then I walk back to the barn. Begonias bloom in the window, pies cool on the sill. Between two maples, starched sheets flap like sails on the clothesline. I take one down and spread it on the grass. "It's time for our game!" I call. In the doorway to the barn he appears—my father, Daddy, John Temple—riffing a deck of playing cards, wearing his gambler's grin. "Get ready, Rosie, my luck's come back!" He strides toward me, into the dazzle, and I swear I'll let him win as many hands as he can play. □



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Due to energy crises, recessions and inflation since 1973, scores of coal and nuclear plants were canceled in

the planning stage. Financial problems caused many utilities to cancel partially completed plants.

These plants and more will likely be needed to avoid electricity shortages in the 1990s. Yet utilities are faced with many obstacles and uncertainties.

Borrowing money for plant construction is increasingly difficult; state rate-setting procedures often discourage new capacity; opposition groups continue to block construction; Federal regulations continue to multiply, often causing the repeated tearing down and rebuilding of plant systems; and high interest rates and prolonged construction periods force electricity bills up.

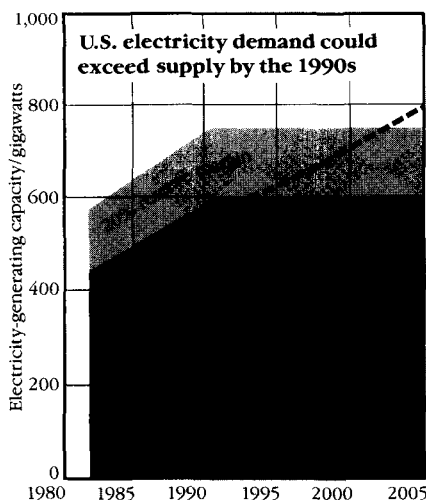
These problems need to be solved through the understanding and cooperation of the industry, government, and the public. Only then will the utilities be able to take the steps needed to prevent electricity shortages and sustain a growing economy.

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If demand for electricity continues growing at an average 3% per year (this year it's around 8%), in the 1990s the utilities' reserve margin could drop below the 20% necessary to assure a reliable electricity supply.

*The ultimate goal of physics
is a theory that explains all matter and
energy. Today physicists may be
close to achieving that goal, in large
part because of the efforts of
Sheldon L. Glashow*

HOW THE UNIVERSE WORKS

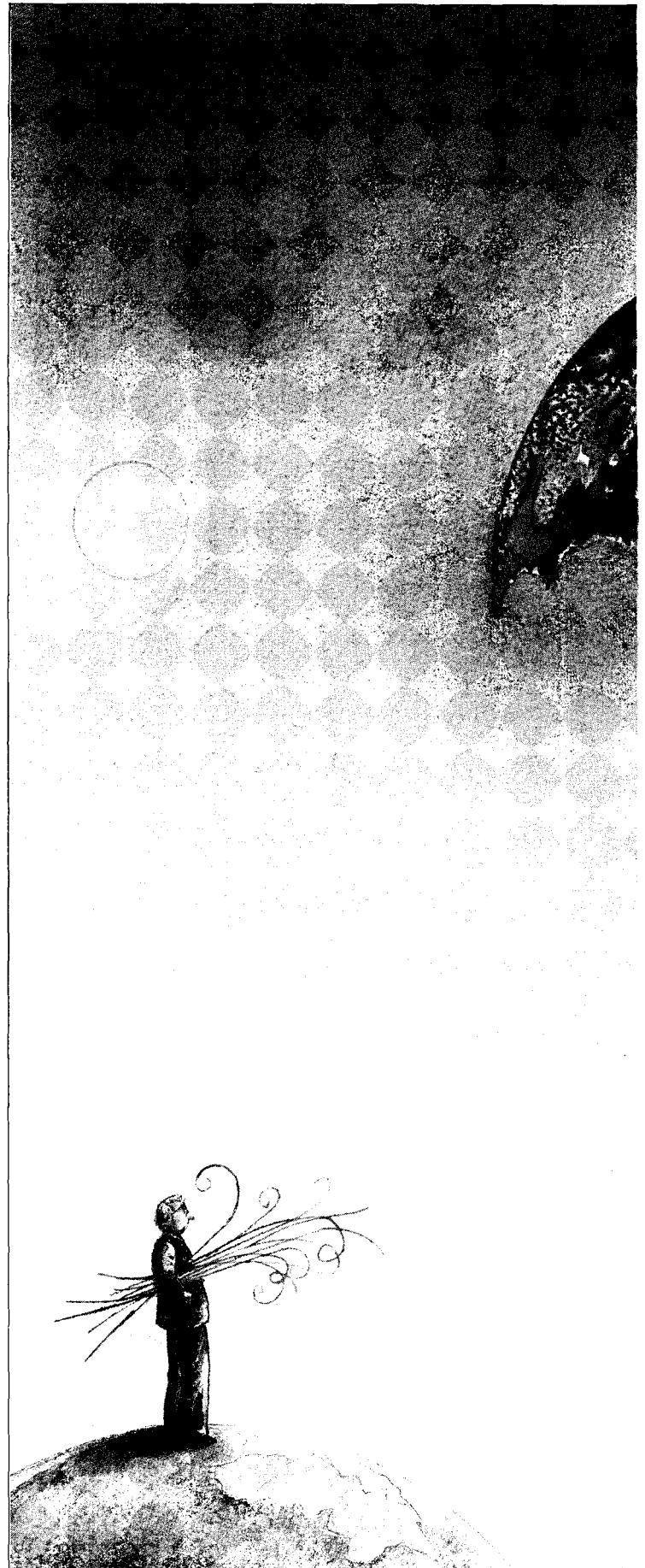
BY ROBERT P. CREASE
AND CHARLES C. MANN

FOR MORE THAN TWO DECADES SHELDON L. Glashow, a physics professor at Harvard University, has sat in a succession of messy offices expending pencils, paper, and malodorous cigars in an attempt to make sense of the dizzying variety of subatomic particles and forces that have been discovered in the past fifty years. It is a convivial task, and one that Glashow claims is a form of play not a jot more useful (for the moment, at least) than painting pictures of soup cans or writing short stories. He spends much of his time arguing with colleagues and friends, cheerfully exhorting graduate students on to greater effort, expounding ideas at seminars: swimming in the great choppy sea of discourse that engenders modern science.

The object of so much talk is to draw within one theoretical picture all matter and energy, from the hottest supernovae to the whirring fragments of the atom. This goal is known as "unification," and in a sense it defines physics as a whole. Whether they knew it or not, all of the physicists who ever lived spent their days laying down bricks in the road to unification. History is littered with discarded notions of how to put it all together; Einstein looked for such a theory for years, and failed completely. In view of this dismal record, the progress achieved in physics since the Second World War is remarkable. Within that relatively short period scientists have taken greater strides toward unification than all of their predecessors put together. Glashow's work has been central to that effort.

Glashow is fifty-one years old. A tall man with a wide face and an innocent expression, he has a fondness for practical jokes, funny names, and silly bets. His thick

Robert P. Crease is an instructor in the philosophy department at Columbia University. Charles C. Mann has written for a variety of national publications.





graying hair, which falls in a tangle over his forehead, needs less to be combed than to be subdued; his glasses are often askew; he speaks with a pure New York inflection untouched by his twenty-two years in Harvard Yard. He is an excellent orator, given to bold declarations and amusing metaphors, but for all his eloquence he is unsure of the public's ability to understand current physics even in outline.

In the fall of 1973 Glashow and one of his colleagues, Howard M. Georgi III, came up with a theory that could account for every known form of matter and for every form of energy except one. At first physicists dismissed as implausible at best what Glashow and Georgi called their "Grand Unified Theory," but over the years, as the compelling clarity of its picture of nature has become widely understood, many have changed their minds and others have proposed variations. Today Grand Unified Theories (or GUTs) compete for the place in physics that the theory of evolution occupies in biology. Just as evolution explains the descent of species, GUTs attempt to explain the descent of matter and, in large part, of energy.

The most startling implication of the GUTs is that the universe is mortal. According to these theories, over a long, long period—so long that it would take at least thirty-one digits to write the number of years—the essential constituents of matter will fall apart, leaving the cosmos vacant of everything but light. If this prediction is true, then humanity is located on a time line in a universe that is destined to vanish.

Scientists in the United States, Japan, India, and elsewhere are testing the GUTs, and although the results are inconclusive, most theorists are convinced that a roughly correct picture of how the universe works at its most basic level has been drawn. The picture is incomplete, but Glashow and his colleagues believe that their work points the way to a full unification. "The outlines are there," Glashow says, his gestures nearly concealed behind an oracular veil of cigar smoke. "There are a few things we don't know yet, but we've killed off a whole lot of fundamental questions that nobody knew how to answer for a long time." In other words, the GUTs are not the end of physics, but they could be the beginning of the end.

Not all scientists agree with that assessment. Skeptics argue that unification will be as elusive, finally, as the Grail. The late Wolfgang Pauli, a fat, ferociously sardonic physicist who sometimes signed his letters "The Wrath of God," dismissed Einstein's unsuccessful search for unity with the apothegm "Let no man join together what God hath put asunder." Julian Schwinger, Glashow's mentor and a recipient of the 1965 Nobel Prize for Physics, speaks of unification as a "fad"—a "grand illusion" that is not "a theory in the usual sense but an aesthetic and emotional glow about how things would work if only we could compute them." Schwinger says, "It's nothing more than another symptom of the urge that afflicts every generation of physicists—the itch to have all the fundamental questions answered in their own lifetimes."

"The Grand Unified Theories are amusing and beautiful, and have a lot of interesting consequences, but they are still speculative," Murray Gell-Mann, a professor of physics at the California Institute of Technology, cautions. (An impatient and enormously erudite man, Gell-Mann is himself the recipient of what he refers to as "one of those Swedish prizes.") He is quick to stress, however, that the GUTs are based on a solid foundation: the great advances achieved by physicists in the 1950s and 1960s. Neither this earlier work nor Glashow's leading role in it is as well known to the public as Gell-Mann thinks it should be.

"It's difficult to come up with anyone else who's been so terribly important to the whole process and gotten so little recognition for it," Gell-Mann says. "I suppose it's partly because of his style. Some people in our field are terribly pompous and can't stand the thought of having a wild man like Shelly become a spokesman. He will get up at a conference and say, 'Well, this is a really ugly idea, and I'm sure it's all wrong, but what the hell, I'm on the program, so here it is.' And the cigars—I'm sure they hate the cigars."

"The thing about him, though, is that at any one time there are only a few physicists who have the right *taste*. Shelly has splendid taste, and much of what he has said about physics has turned out to be right—that is, when it hasn't been completely off the wall."

A HUNDRED YEARS AGO THE SCIENCE OF PHYSICS split into two branches—one experimental and one theoretical—and there has been less communication between them than might be supposed. Experimenters try to measure the properties of matter, and in doing so they strengthen or destroy the models that theorists construct. One group tends to outpace the other. A theoretical insight will leave experimenters with nothing to do but confirm predictions to a dozen decimal places, or an unanticipated experimental discovery will lay waste to years of theoretical work.

At the end of the nineteenth century many physicists were convinced that their picture of the universe was essentially complete. Atoms, which had recently been shown to exist, were thought of as little spheres resembling infinitesimal billiard balls; two forces, electromagnetism and gravity, arranged these balls into molecules and clumped the molecules together into planets. So certain were some theorists of their knowledge that John Trowbridge, the head of the Harvard physics department, urged gifted students to select another field, because, he said, there was nothing of importance left to do in his discipline.

By 1932, the year Glashow was born, experimental discoveries had demolished the complacency of the theorists several times over. The atom had been discovered to consist of a cloud of negatively charged electrons surrounding a nucleus that is composed of positively charged protons and uncharged neutrons. The nucleus had been found to

display such peculiar features that theorists were able to explain them only by hypothesizing the existence of two new forces.

For one thing, theorists wondered why the electrical repulsion of the protons within the nucleus didn't cause it to fly apart. Something must hold it together, they reasoned. Because ordinarily that something would have to be about a hundred times more powerful than electromagnetism, it came to be known as the "strong force."

Moreover, the nucleus had been discovered to be the locus of radioactivity, one rare form of which proved so resistant to explanation that theorists finally threw up their hands and said that it had to be caused by yet another force, and an extremely feeble one at that. If its effects were almost always swamped by those of the electromagnetic and strong forces, then that would explain why they were not often observed. This force theorists called, logically enough, the "weak force," and ordinarily it is trillions of times less powerful than electromagnetism.

The behavior of the strong and weak forces appears to be considerably different from that of electromagnetism or gravity. The strong and weak forces are felt only over extremely short distances—on the order of a hundred trillionths of an inch. But within that small realm they play a grand role indeed, causing particles to change many of their properties and even to come into or pass out of existence. (Because "force" sounds like simple pushing and pulling, physicists also refer to forces as "interactions.")

Today electromagnetism, the strong and weak interactions, and gravity are thought to be the basic forces of the universe, from which all others—muscle power, the pounding of the tides, the sudsing action of detergent, and nuclear explosions, to mention a few—derive. Electromagnetism and the strong and weak interactions directly influence the busy comings and goings of the subatomic world, and therefore are known as elementary-particle forces. The fourth force—gravity—is odd man out. It has almost no effect on individual atoms, but its slow, patient pull keeps the planets in orbit and gathers the stars into galaxies.

The discovery, in the first twenty years of this century, of the unexpected world within the atom engendered a half-dozen branches of physics, with names like quantum mechanics, subatomic physics, cosmic-ray physics, nuclear physics, high-energy physics, and particle physics. In recent years all or part of these subdisciplines have been subsumed into what is known as "quantum field theory." The spawning ground of the GUTs, quantum field theory is conceivably the most outré—and certainly the most glamorous—area of physics. With its arcane vocabulary and metaphysical resonances, it has attracted considerable public attention, for it promises to put the house of reality in order.

The quantum realm was conceived early in this century by Max Planck and Albert Einstein, who arrived at the conclusion that light consists of tiny units and is not the uninterrupted flow that common sense suggests. Just as a

beach, which looks smooth and continuous from afar, from close up can be seen to be composed of grains of sand, so ordinary light is composed of countless "grains" of light. Planck called these particles *quanta*, from the Latin word for "how much." And physicists soon realized that all forms of energy, not just light, come in quanta.

The idea of quantized energy took theorists a step away from the conventional view of the world. They went a reluctant step further when experimental data forced them to marry the idea of quanta to a much older notion—that of the field. A field is a region of space in which certain quantities are precisely defined at every point. For instance, the pattern of arcs that iron filings form around a magnet illustrates the magnet's field. Each point along each arc is subject to a force of a particular strength and direction. The alignment of each filing indicates the direction of the field at that point, and the density of the filings indicates the field's strength. Fields can be defined for such diverse domains as temperature, sound, and matter. Pauli, Werner Heisenberg, P. A. M. Dirac, and others spent their time during the late 1920s showing that both subatomic particles and energy quanta can best be described as fields and that the hurly-burly of subatomic affairs should be thought of as a set of interactions among various types of fields.

A CORNERSTONE OF QUANTUM FIELD THEORY IS Heisenberg's famous "Uncertainty Principle," which he formulated in 1927. Like many scientific laws, the Uncertainty Principle can be stated in several ways, one of which is as follows: When you shine a light to look at something, you bounce light off it. Because a quantum of light—a "photon"—is, in a manner of speaking, the same size as a subatomic particle, when you look at such a particle the two will knock each other around. (To picture this, imagine trying to find out where somebody is by bouncing a bicycle off him.) This interaction between particles and photons, Heisenberg discovered, means that many of a particle's characteristics—including such important ones as its position, velocity, and energy—can never be specified simultaneously. The act of measuring one interferes with the measurement of the others.

The Uncertainty Principle marked a fundamental break between quantum field theory and classical physics. Many physicists, including Einstein, were dismayed by the idea that anything should be inherently unknowable. Their dismay increased as the full implications of Heisenberg's work became apparent.

According to the Uncertainty Principle, the energy of a field over any given period cannot be determined exactly—a small but irreducible margin of error is unavoidable. Paradoxically, the less time one spends measuring, the greater this margin of error becomes. It is therefore conceivable that within an interval on the order of trillionths of a trillionth of a second a field might contain a vast amount of energy that escapes detection.

This logic has unnerving consequences. According to

Einstein's equation $E = mc^2$, mass and energy are two forms of the same thing. Thus the Uncertainty Principle dictates that if any small area can contain undetectable energy, then, according to Einstein's equation, it can contain undetectable matter. For all physicists know, apparently empty space is filled with particles that pop in and out of existence beyond their reach. And worst of all, the Uncertainty Principle shows that this bedrock uncertainty about the contents of a field is not just an unfortunate defect of the tools available to physicists. Mathematically there is no difference between this margin of error in measurement and an actual random fluctuation in the energy (or matter) measured. Thus, at least in theory, because any space *might* harbor particles for a short time, it *must* do so.

The Uncertainty Principle exposed a frightful chaos in the lowest order of matter. The spaces around and within atoms, previously thought to be empty, were now supposed to be filled with a boiling soup of ghostly particles. Small wonder that many theorists, including Einstein, were appalled. From the perspective of quantum field theory, the vacuum contains random eddies in the field of space-time: tidal whirlpools that occasionally hurl up bits of matter only to suck them down again. Since these bits virtually don't exist, they have been named "virtual particles."

Far from being a bizarre anomaly, virtual particles are a central feature of quantum field theory. Shortly after the Uncertainty Principle demonstrated their existence, Heisenberg, Pauli, and others postulated that electromagnetism—the phenomena of light, electricity, and magnetism—itself consists of nothing more or less than charged particles batting virtual photons around among themselves, for all the world like a group of jugglers exchanging tenpins. It is an odd picture of the origins of electricity and magnetism, this churning that now attracts, now repels, the charged snippets of matter in atoms. Today physicists think it lovely, but at first they were dismayed.

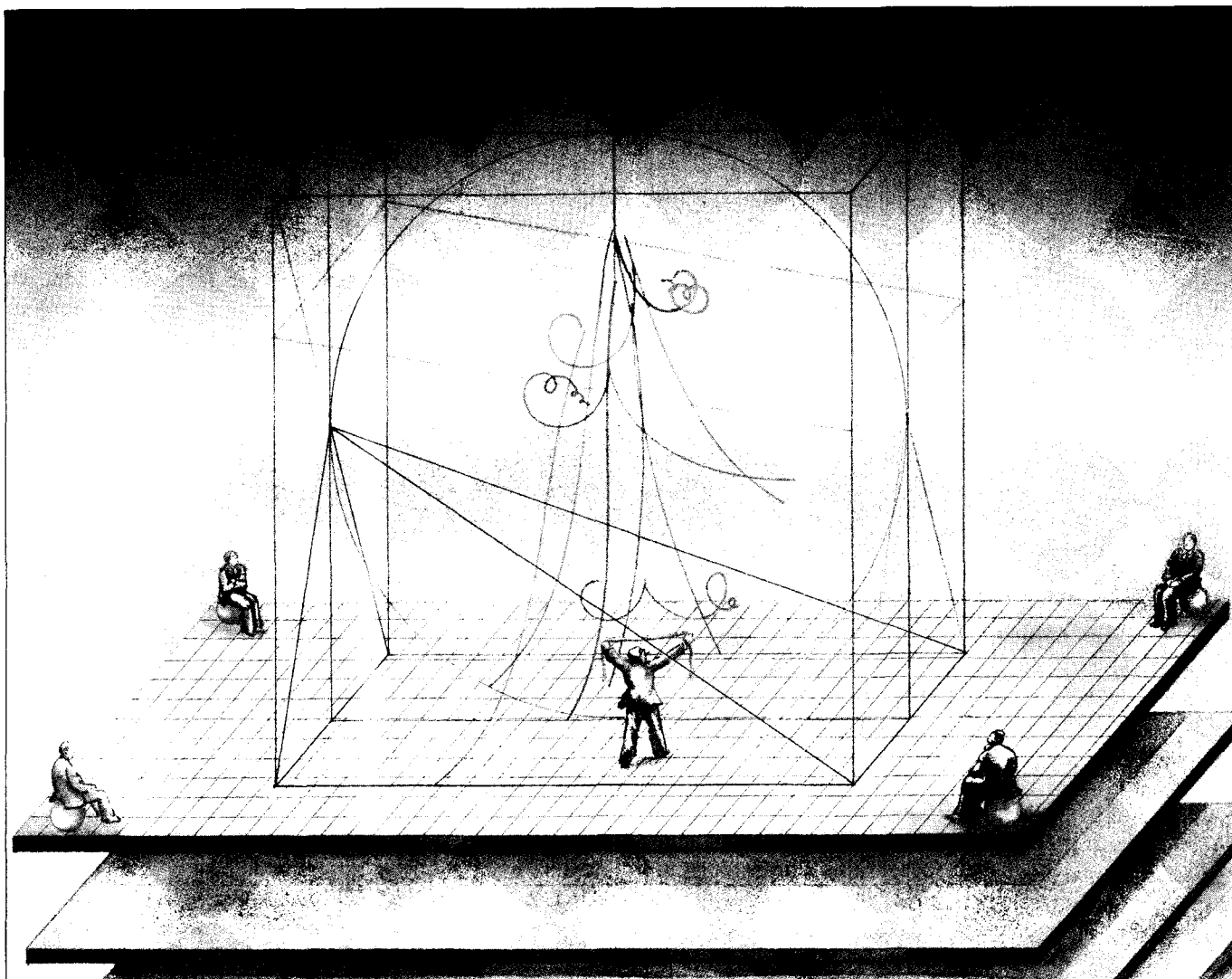
Those skeptical of this description of electromagnetism were buoyed by the March 1, 1930, issue of the journal *Physical Review*, which contained an article by a brilliant twenty-five-year-old physicist named J. Robert Oppenheimer. Oppenheimer, who would later become the head of the program to build the atomic bomb, tried to calculate precisely what would happen to a single electron if it were surrounded by a swarm of virtual photons, as field theorists had described. This task involved adding up the total number of ways in which an electron can interact with a quantum of light that appears out of nowhere. Because the number of possible interactions is infinite, the answer proved difficult to calculate. In fact, Oppenheimer couldn't come up with an answer that made sense. Therefore, he stated that the theory as a whole did not make sense, because one couldn't get meaningful answers out of it. Oppenheimer believed that he had shown that the theory was not, to use modern terminology, "renormalizable," which was tantamount to saying that it was worthless.

Throughout the 1930s Oppenheimer, Pauli, Heisenberg himself, and most of the other luminaries of physics were

convinced that the infinities were nature's way of telling scientists that they were barking up the wrong tree, and that quantum field theory would have to be junked in favor of something else. Theorists searched fruitlessly for alternatives until shortly after the war, when Willis Lamb, an experimental physicist who was then at Columbia University, jolted the physics community with the news that he had actually measured the effects of virtual photons on the orbit of electrons—exactly the quantity that Oppenheimer, using pencil and paper, had tried and failed to calculate. Spurred in part by Lamb's feat, two theorists—Julian Schwinger, then at Harvard, and Richard Feynman, then at Cornell University—realized that if they juggled the equations of quantum field theory around and rephrased certain terms, some of the infinities could be made to cancel out others, leaving a finite residue. (Similar work had been done by the Japanese physicist Shinichiro Tomonaga, but postwar conditions prevented him from playing a role in the final formulation of the theory. For this work Feynman, Schwinger, and Tomonaga shared the Nobel Prize for Physics in 1965.)

The renormalized quantum field theory of electromagnetism is called "quantum electrodynamics," or QED. The most exact scientific theory ever produced, QED is one of the major intellectual triumphs of this century. The theory encompasses, among other things, all of chemistry, which has as its base the principles governing the electrical forces that bind atoms into molecules.

Aglow with the thrill of discovery, Feynman, Oppenheimer, Schwinger, and others tried to apply the mathematical language of QED to the strong and weak interactions—a crucial first step toward unification. Their efforts ended in failure. They came up with a plausible theory of the weak interaction that could account roughly for most of the known data, but despite calculations that covered acres of blackboard space, they could not renormalize it. They devised a theory of the strong interaction which they *could* renormalize, but experimental findings disproved it utterly. To make matters worse, a discovery by the British experimenters G. D. Rochester and C. C. Butler called the entire enterprise into question. In 1947 Rochester and Butler came across two new particles exhibiting a trait that had not been seen before. If the methods of QED could truly be extended to the strong and weak interactions, then these particles should have perished as they were born, pulled apart by the strong force that governed their creation. Instead they mysteriously clung to life until the weak interaction finally caused them to fall to pieces. At the age of twenty-three Gell-Mann made a name for himself by suggesting that their unexpected persistence was not a variant of properties already known but in fact a new property that identified a new class of matter. He called this property "strangeness," and the particles "strange particles." Strangeness was another wrench thrown into the works of quantum field theory, and for the second time theorists began to wonder if any part of the theory—any at all—was correct.



AT THE EXTREME NORTHERN TIP OF MANHATTAN IS A little side street, Payson Avenue, which runs uphill for a long block beside Inwood Park. Facing the grass and trees is a row of small two-story houses, one of which—number 65—was Glashow's boyhood home. Glashow says, "It was a glorious place to grow up—in a real house, next to a park, in an intellectually active half-Jewish, half-Irish neighborhood."

Glashow's father, Lewis Gluchovsky, had come from the town of Bobruysk, in White Russia, where the family had owned a Turkish bath house ("the public baths of the city," Glashow says). When he arrived here, the immigration authorities changed his name; shortly thereafter Gluchovsky/Glashow became a plumber in Manhattan. He married another immigrant, Bella Rubin. They had two boys, aged fourteen and eighteen, when the third, Sheldon Lee, was born. One of Glashow's brothers became a doctor, the other a dentist. Sheldon decided at the age of eight or nine that he wanted to be a scientist.

"It was the beginning of the Second World War. People were interested in those days in identifying airplanes and understanding how bombs are dropped, and I got curious about the ballistic problem. My brother explained to me

that if a plane drops a bomb and doesn't take some evasive action, the bomb is going to blow up right underneath where the plane is *going* to be. That of course struck me as a very odd fact, because the assumption is that when the plane drops the bomb, the plane is moving forward and the bomb is not.

"I had a little notebook, this black-and-white speckled notebook that kids still have. My brother would write little lessons—two or three or five such lessons—about things he had learned. Not long before, Harold Urey had discovered heavy water, and Urey was his professor in school, so he was a little turned on about it, and he communicated that to me."

Lewis Glashow was not entirely pleased by his son's interest in science. "My father told me that science would be all right, but why didn't I do it in my spare time and go into medicine, like my brothers," Glashow says. "I differed with him slightly about that. He relented when my brothers came back safely from the war. When I entered high school, he helped me build a chemistry lab in the basement, where I loved to perform long and dangerous experiments."

Glashow's passion for science was not directed to phys-

ics until he entered the Bronx High School of Science, in 1947. After classes the boys in the Science Fiction Club—there were no girls—would cluster around an old laboratory table littered with hospital-surplus Bunsen burners and the tracery of test-tube racks. The preferred topics of discussion included the contents of a magazine called *As-tounding Science Fiction* and the ideas of L. Ron Hubbard and Immanuel Velikovsky. Two of Glashow's best friends in the club were Gerald Feinberg and Steven Weinberg. (Feinberg became a distinguished physicist and has written several respected books. Glashow and Weinberg shared the Nobel Prize for Physics in 1979.) All three contributed to the Science Fiction Club's magazine *ETAION SHRDLU*; the name is a term from typography.

The founder of Bronx Science, Morris Meister, was a pioneer of fast-track education and a tireless advocate of the notion that if bright, science-oriented students are brought together, certain ill-defined but nonetheless valuable learning processes will occur. As far as Bronx Science is concerned, he seems to have been right. Since the school's founding, in 1938, it has produced three winners of the Nobel Prize for Physics—more than any other high school in the world ever has, and more in those forty-six years than most countries, including France and Italy.

Considering that statistic, it is surprising to learn that the physics taught to Glashow, Feinberg, and Weinberg was of dubious merit. Feinberg says that the instructor who taught his introductory section “for all we could tell did not believe in the existence of atoms.” Students interested in pursuing advanced physics were offered a choice, between automotive physics, in which an old Curtiss-Wright airplane engine was soberly taken apart and put back together each semester (a good course “for those who realize that the automobile is here to stay,” the 1950 year-book states), and radio technology, in which the class assembled shortwave kits of the sort advertised on the back cover of *Boys' Life*. Glashow took neither.

Despite the modest course offerings, a kind of underground science took place outside the classroom. Glashow persuaded his mother to buy him college outline texts whenever she dragged him downtown to shop; at lunch Feinberg often led excited conversations about quantum mechanics. Most important was the give-and-take among the club's members; the boys competed with one another to reach the most complete understanding of the latest scientific discoveries, but they also helped stragglers to catch up. Feinberg says, “After the meetings Shelly and I would spend hours on the phone talking about science. It drove our parents crazy. We were sure we were going to find wonderful things.”

After graduation Feinberg chose to stay in New York City and go to Columbia. Glashow and Weinberg went upstate, to Cornell. Although Cornell has become an internationally important center for physics, in the early 1950s it had the nickname “Moo U” and was known chiefly for agricultural science. Cows grazed on the lawn, and campus lore had it that professors were not allowed to eject dogs

that might stray into their classrooms. Although some prominent physicists were at Cornell when Glashow and Weinberg entered, in the class of 1954, their courses were restricted to graduate students. Those who taught undergraduates regarded most forms of collaboration among students as dishonest, and after Bronx Science Glashow, at least, found that attitude hard to take. He says, “There was a style mismatch. Some of us were thrown out of the school for cheating. We would collaborate on their dumb problem sets and they didn't like that, for example. One of us would show up with six copies of homework—sort of identical homework—and the teacher would simply ask if one of us wanted the 100 percent credit or if we wanted to divide it up.”

In his senior year Glashow was exposed for the first time to quantum field theory. He was the only undergraduate in the class, and the subject baffled him. At exam time the professor, Silvan Schweber, was nonplussed by the fact that although he could give all of the graduate students pass-fail grades, he had to give an undergraduate a numerical one. Glashow recalls: “So he said, ‘How about an 85?’ Which was not too low, not too high. I wanted to try for something better, so I said, ‘No, give me an exam.’ Schweber asked me a bunch of questions, and I got every one of them wrong. At the end he said, ‘How about an 85?’ I said, ‘Great!’”

Despite his trials, Glashow learned some physics, mostly in the same way he had learned in high school—by shooting the breeze with his friends. He argued with Weinberg, dashed off letters to Feinberg, and dropped down to New York City on weekends to hear lectures. Perhaps the most important material he absorbed came from one Harold V. McIntosh, a graduate student who had decided to pursue physics at Cornell after he had gotten a degree from the Colorado School of Mines. Brainy and eccentric, McIntosh had a little coterie of enthralled undergraduates whom he introduced to his current obsession: the mathematical theory of groups. Glashow says, “He was always coming up to me with problems involving vibrating bedsprings and jiggling ozone atoms and things like that, which he claimed group theory was capable of solving. Actually, what I learned from him was as relevant as any course I took.” (The last Glashow heard, McIntosh was teaching physics in Mexico.)

Glashow chose to do his graduate work at Harvard, where he hoped to write his thesis under Schwinger, one of the heroes of the effort to renormalize QED. At first Glashow found Harvard no better than Cornell. “Nothing is quite as dull as being here,” he wrote to Feinberg. He saw Schwinger rarely and considered the classes he took insufferably tedious.

By Glashow's second year, however, he was taking courses from the master, an experience that he found both electrifying and peculiar. A charismatic teacher, Schwinger would lecture at lightning speed, covering the blackboard with equations, many of which he expressed in his own idiosyncratic system of symbols. Regardless of the descrip-

tions in the catalogue, Schwinger's advanced graduate courses were always about whatever Schwinger was working on at the moment. He would sometimes begin class with the news that what he had said the day before was wrong. Glashow loved him.

A shy man, Schwinger had a reputation for aloofness outside of class. His students claimed that all they ever saw of him was the flash of his florid silk tie as he ducked into the men's room to avoid them. ("He suffers from an uncertainty principle," Glashow says.) Nevertheless, Glashow, at the beginning of his third year, asked Schwinger to be his thesis adviser. So did eleven other students. To Schwinger's consternation, he found all of them waiting in his office one day. Thinking to test their abilities individually and avoid dealing with them as a pack, he devised an enormously complicated problem and instructed the multitude to work on it and return, one by one, with their solutions.

"So of course we collaborated," Glashow says. "The twelve of us came back a few days later, all at the same time, having solved the problem. He was happy with the solution—it was elegant—but not so happy with the complete failure of his scheme to sort out the masses. So he then came up with a different problem for each of us and in that way, against his will, got us all started on our theses."

The question for Glashow was based on a hunch. As early as 1941, even before Schwinger helped to renormalize QED, it had occurred to him that it might be possible to show that the weak force and electromagnetism were aspects of the same phenomenon. Schwinger says, "I mentioned this to Oppenheimer, and he took it very coldly. After all, it was an outrageous speculation." Although Schwinger turned his attention elsewhere, the idea stayed with him. In 1956, almost casually, he gave the task of checking it out to Glashow.

AT HALF PAST FOUR ON THE AFTERNOON OF DECEMBER 10, 1979, Glashow entered the auditorium of the Stockholm Concert House to a flourish of trumpets. Directly behind him were his old classmate Weinberg and a physicist named Abdus Salam, who was wearing full Pakistani formal regalia, including shoes with toes that curled several inches in the air. (Salam teaches at the International Centre for Theoretical Physics, in Trieste, and the Imperial College of Science and Technology, in London.) In a ceremony that took several hours, the three were awarded a Nobel Prize, not for any Grand Unified Theory but for a theory that made the GUT possible—one incorporating the weak and electromagnetic interactions. This "electroweak" theory grew out of the Ph.D. thesis that Glashow began working on in 1956; it came together in 1971. Glashow and Georgi formulated their GUT in 1973—six years before Glashow won the prize for work that he considers an intermediate step toward that theory.

A Nobel laureate is obliged to give a speech before the week of festivities is over. Glashow's was mainly an at-

tempt to convince any remaining doubters that the recent work in particle physics constituted a fundamental advance. He opened by recalling the time when Schwinger had started him on his career.

"In 1956, when I began doing theoretical physics, the study of elementary particles was like a patchwork quilt," he said. "Electrodynamics, weak interactions, and strong interactions were clearly separate disciplines, separately taught and separately studied. There was no coherent theory that described them all."

"Things have changed," Glashow told his audience. "Today we have what has been called a standard theory of elementary particle physics, in which strong, weak, and electromagnetic interactions all arise from a [single] principle. It is, in a sense, a complete and apparently correct theory, offering a qualitative description of all particle phenomena"—an enormous achievement, tossed off in a phrase—"and precise qualitative predictions in many instances. . . . The theory we now have is an integral work of art: the patchwork quilt has become a tapestry."

A physical theory, like a tapestry, is woven within a frame. Newton could not have put together the laws of mechanics if he had not first invented a language in which to write them: calculus. Similarly, Einstein could not have understood the odd geometry of general relativity if a sickly German named Georg Friedrich Bernhard Riemann had not first dreamed up an apparently impractical branch of mathematics in which parallel lines could meet: Riemannian geometry. And Glashow could not have written his doctoral thesis if he had not happened to come across a beautiful but mostly empty loom known as gauge field theory.

Modern gauge field theory was created largely at Brookhaven National Laboratory in 1954, by the physicists Chen Ning ("Frank") Yang and Robert Mills. In a short paper published that year in *Physical Review* Yang and Mills built the frame upon which modern quantum field theory has been woven. At first their ideas were dismissed by all but a few as pure mathematics, without any physical significance. Now, partly as a result of Glashow's work, the drive toward unification has boiled down to a quest for a Yang-Mills gauge field theory powerful enough to account for every particle and force in existence.

The basic idea of the paper had occurred to Yang in 1947 and 1948, when he had been a graduate student at the University of Chicago. He had recently come from China, where his father was a mathematician, and he was fascinated by the use of different formal methods to describe the same thing from varying perspectives. In particular, he was intrigued by the region of mathematics known as gauge theory, which describes the relationship between physical forces and the symmetries that underlie them.

Used loosely, "symmetry" means harmony or balance. Physicists and mathematicians, however, define the term more precisely. They say that something is symmetrical if one or more of its aspects is indifferent to a change. A rubber ball can be turned freely and its appearance won't be

altered; therefore, as a physicist might say, the ball is "symmetric about its shape." In gauge symmetry a change in one aspect of a phenomenon is precisely compensated for by a change in another aspect, so that a quantity related to both aspects remains the same.

This kind of compensation can be likened to the drawing of contour lines on a topographic map. Say that the mapmaker has decided to let the distance between any two contour lines correspond to a ten-yard rise or fall in elevation. (The farther apart the lines, the flatter the terrain.) If a volcano changes the lay of the land, the position of the lines on the map will have to be changed as well, to compensate for the newly created steepness. The gauge field has the role in particle physics that the mapmaker has in cartography; it preserves an unchanging relationship between two or more changing phenomena.

The simplest example of a gauge theory is QED (the theory of electromagnetism). In this case, what always remains the same is the net electric charge of a particle or group of particles.

Just as someone who has never played chess must watch a game for a while before he can pick out the usually untouched kings as the most important pieces on the board, it often takes scientists a while to discern the central aspect of any phenomenon. Physicists had known since the 1930s that electromagnetism could be described as a gauge field, but most had left it at that. It occurred to Yang when he was in graduate school that such a description might be essential to understanding electromagnetism, and also that there might be other kinds of gauge fields. Five years later he mentioned the idea to Mills, his office mate at Brookhaven. According to Mills, "He and I just asked ourselves, 'Here is something that occurs once. Why not again?'"

To find a gauge symmetry like the one for electric charge, Yang and Mills reached into the bag of terms that physicists use to describe subatomic particles and seized upon "isotopic spin." Coined by Heisenberg in 1932, the term refers to a way of classifying the proton and the neutron. These two particles are identical in almost every respect; electric charge is the only important difference. Heisenberg wondered if theorists might make headway by considering the proton and the neutron to be different states of the same particle, in somewhat the same way that the isotopes carbon-14 and carbon-12 are slightly different versions of the element carbon. To describe this relationship formally, he proposed that the two particles be thought of as spinning like tops in some imaginary space. If the axis of spin points up, the particle has a positive charge and is a proton; if the axis points down, it has no charge and is a neutron. Heisenberg expressed this relationship by saying that the proton and the neutron should be assigned the same value—the proton plus and the neutron minus—of the hypothetical entity that he called isotopic spin.

All of Heisenberg's theorizing would have been only a game if experimenters had not discovered that nature was playing too. Just as the net amount of charge is constant in

electromagnetic interactions, isotopic spin turned out to be constant in strong interactions of all kinds. Thus Yang and Mills hypothesized that because a particle's charge is preserved by a gauge field (i.e., electromagnetism), isotopic spin might be preserved by some other gauge field. And they asserted, just to see what would happen, that the gauge field for isotopic spin is governed by the interactions of certain virtual particles, which they called "vector bosons." (The term refers to aspects of these particles that play no role in this discussion.)

Yang and Mills hoped that their equations would work out such that these vector bosons, which nobody had ever observed, would prove to be associated with the strong interaction. Gauge fields would then be a language appropriate not only to electromagnetism but also to the strong force. They would catch both in one net.

When Yang and Mills did the mathematics, the equations came out right if vector bosons had electric charge but no mass. This was most discouraging. A massless particle, such as the photon, is easy for experimenters to make and a charged particle, such as the electron, is easy for them to detect. Yang and Mills could not understand why massless charged particles, if they existed, had not already been discovered. ("That was the embarrassment of it," Glashow says. "This lovely theoretical idea ended up predicting these massless charged particles that could not possibly exist!") Even though nature didn't seem to be cooperating, Yang and Mills thought that their idea was so beautiful that they went ahead and published it.

BECAUSE YANG AND MILLS HAD COME UP WITH A wholly new way to look at the forces among elementary particles, their work interested many physicists. Yang and Mills in effect were telling their colleagues: "Look at particles. See if you can find any unchanging properties, and try to imagine a gauge field that might account for them. Work out the properties of that fictional field and its associated virtual particles. Are they anything like the real world?"

One of the physicists who paid attention was Schwinger. Characteristically, he rederived the whole mechanism in his own way, and in his own notation. But instead of using a Yang-Mills gauge field to look at the strong interaction, as most of his colleagues were doing, Schwinger considered the weak one. And in October and November of 1956 he dazzled his students, including Glashow, with a series of public lectures purporting to explain the weak force in terms of gauge theory.

Out of the lectures came a paper entitled "A Theory of the Fundamental Interactions," which was published in the journal *Annals of Physics* in November of 1957. The most important part of Schwinger's theory had to do with particles called "leptons," which are unique in that they respond to the weak force but not to the strong. By 1956, when Schwinger was lecturing about his idea, three types of leptons had been discovered: the familiar electron; the

muon, which is exactly like the electron except that it is 200 times heavier; and the neutrino, a particle so small that it may have no mass. All are as impervious to the strong force as a tree stump is to a magnet. Schwinger conjectured the existence of *two* types of neutrino—one associated with the electron and one with the muon.

Schwinger needed the first speculation to make a second bit of speculation come out right. He postulated that the weak force is carried among the leptons by three particles: the photon and two hypothetical vector bosons, which are now called W^+ and W^- . Although most physicists regard his work as being based on that of Yang and Mills, Schwinger came to his ideas from a different path.

There had to be *two* vector bosons to account for the way in which weak interactions convey electric charge. When the weak force transmutes an uncharged neutron into a positive proton and a negative electron, a virtual particle is emitted, and in its decay an electron is created. (Any such emission and subsequent decay is called a "current.") Schwinger argued that when the weak force transfers a positive charge, the current is carried by a positive version of the vector boson, the W^+ , whereas when the weak force transfers a negative charge, the current is carried by a negative version of the vector boson, the W^- . He further hypothesized that the familiar photon is the intermediary when no charge is involved.

Schwinger told his graduate students that this picture of the weak force had far-reaching consequences. Because the photon and the W s make up a triplet, Schwinger said, electromagnetism and the weak interaction should be treated as part and parcel of the same phenomenon: that is, he had unified them. But he was more cautious in print, as is proper. He never used the word "unification" in the paper, but referred instead to the weak force as "a partner of the electromagnetic field."

There was no compelling reason for his suppositions; Schwinger merely wanted to demonstrate that his pet notion could be used to construct a coherent theory. In addition, he found the result aesthetically pleasing. His colleagues did not. When Schwinger went to New York City to visit his former teacher Isidor I. Rabi, at Columbia University, Rabi told him bluntly, "Everybody hates that paper." Upset by the reaction, Schwinger was further distressed to learn that the experimental data he had relied on were wrong. (As it turned out shortly thereafter, only part of those data were invalid, and Schwinger was much closer to a successful electroweak theory than he or anyone else knew. Abdus Salam says, "If those experiments hadn't been wrong, he might have gotten the entire thing then and there.") Schwinger gave up in disgust and turned to other areas of physics.

Before he did, though, he asked Glashow to look into the possibility of a connection between the weak and electromagnetic interactions—to see if a connection could still somehow be established. "It was a vague request," Glashow says. "He asked me to think about it. And that's what I did for two years—think about it."

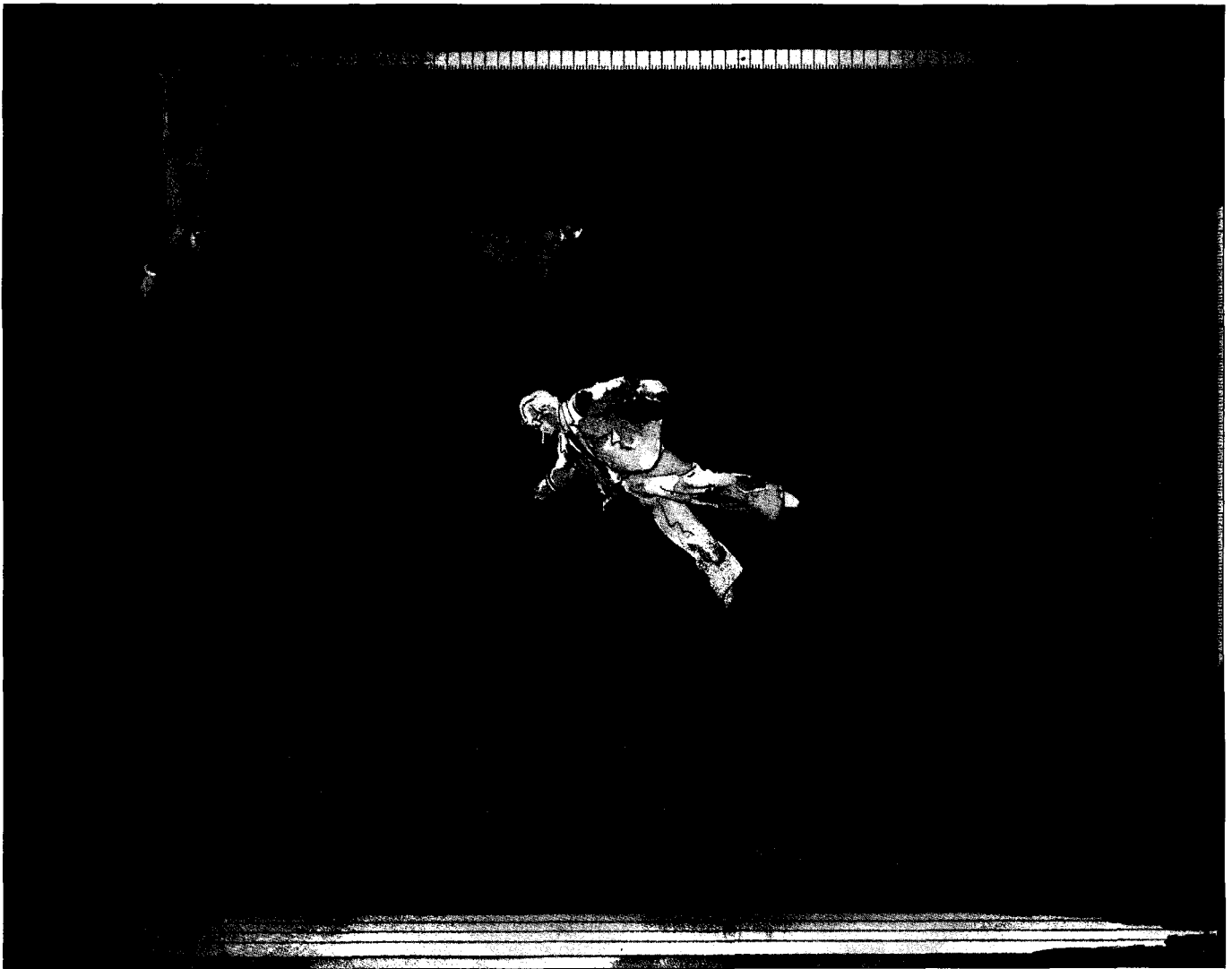
Today Glashow's thesis—the product of those two years of thought—sits on his bookcase, stuck in a black spring binder on a neglected top shelf. He has to hunt for it, wading through the stacks of preprints and journals that clutter his office, when he wants to show it to visitors. On a bulletin board beside the door are many strata of notes and memos, including letters from a physics student in Beijing who claims to have discovered antigravitation ("Is *most* important result!"), newspaper advertisements explaining that Transcendental Meditation can harness the power of the Grand Unified Field, and a number of clippings about the Soviet physicist Andrei Sakharov, in whose defense Glashow has been active. "Here it is!" Glashow says, standing on a wobbly stool. He hefts the volume appreciatively. "These things are always long, to show you have lots of bright ideas, and filled with tons of calculations—student showboating. Mine is a complete parade of crazy digressions. I haven't looked at this in *years*. But there's one part I'm still proud of. Here, wait—it's in the appendix."

This is no surprise. Graduate students traditionally hide their most radical statements in footnotes and appendices, where they can be disavowed if necessary. Glashow sits at his desk wreathed in cigar smoke and shakes his head at the maunderings of his youthful self. When he finds the page, he sticks a finger into the air.

"Yes. 'It is of little value to have a potentially renormalizable theory of beta processes [another name for weak interactions] without the possibility of a renormalizable electrodynamics.' That's because the W s are charged, so you had to get into QED to talk about them. Here we go. 'We should care to suggest [his voice rises here; his pleasure in the younger Sheldon Glashow is apparent] that a fully acceptable theory of these interactions may *only* be achieved if they are treated together.'"

He snaps the binder shut, kicking up a little cloud of dust. "That's the basic idea of the electroweak theory right there—that the weak interaction would never make any sense by itself, because it's always mixed up with electromagnetism. So you have to look at them together. It sounds simple, but that kind of realization is a big deal. Before Newton could work out his theory of gravitation, he first had to realize that the force that moves the planets around the sun and the force that drops apples on people's heads are the same thing. So, in a certain sense, that sentence won me the Nobel Prize. It took thirteen more years"—until 1971—"to show that I was right, but damn it, I was."

WHILE WORKING ON HIS THESIS GLASHOW WON A National Science Foundation Fellowship, a prestigious award that entitles its recipient to study abroad. Glashow spent two years, from 1958 to 1960, at the Niels Bohr Institute for Theoretical Physics, a center established after the First World War by the eminent scientist for whom it is named, and affiliated with the Universi-



ty of Copenhagen. The Bohr Institute every year invites a few young physicists to participate in the discussions held there. Glashow attended lectures, gave talks, met the great Bohr, and in general lived the life of which he had dreamed years before at Bronx Science.

At the institute Glashow expanded the appendix of his thesis into a paper, "The Renormalizability of Vector Meson Interactions," which he submitted to the journal *Nuclear Physics* in the fall of 1958. (Maddeningly, physicists at that time used "vector boson" and "vector meson" interchangeably. Today they are careful to distinguish between the two, and hereafter this article will correct any outdated usage.) Glashow was referring to what are now called vector bosons. He wanted to prove that tying electromagnetism and the weak force together would produce a coherent and renormalizable theory. By November, when he submitted his paper, he thought he had it.

Pleased with himself, he went to England in the spring of 1959 to present his work. "I lectured in London or somewhere," he says. "They all sat there smiling very politely, told me that they liked what I was doing, and went home to tear it apart." Abdus Salam was in the audience; for years after, he says, he didn't trust Glashow's work. For

Glashow the episode was embarrassing and annoying—a nightmare. ("They don't make graduate students that dumb anymore," he groans.)

The reaction to the London lecture forced Glashow to make a choice more dependent on his personality than on the rules of scientific inquiry. Young theorists have to come up with bold ideas if they are to acquire reputations, yet their papers cannot be half-baked. Glashow's idea had been bold, but it was wrong. If he kept going, he risked being labeled an eccentric; if he went on to something else, it would be an admission of defeat. Glashow chose not to abandon unification; instead he advocated an even wilder, more speculative extension of his original position.

His decision to hold to unification was more than simple muleheadedness, however. Glashow has that lucky intuition—the right taste, as Gell-Mann says—that is a gift for selecting the correct road in advance of, and sometimes even against, the data and stubbornly following it heedless of scorn or, worse, indifference. He threw himself into the sequel, turning over his ideas with the bemused care of a raccoon washing a shiny ring.

In March of 1960, after Glashow gave a talk in Paris, Gell-Mann, whom Glashow had never met, invited him to

lunch. Gell-Mann was then in the middle of an extraordinary decade during which he dominated particle physics, and Glashow was more than happy to be his guest. They went to a seafood restaurant. Glashow mentioned having an aversion to fish; Gell-Mann explained that serious people like seafood, that he knew that Glashow was a serious person, and that therefore he would order fish for both of them. ("Murray's all the things people say he is—arrogant, intolerant, and so on—but I love him," Glashow says. "I've been terribly lucky, working right off the bat with two great physicists—Julian, and then Murray.")

Over the entrée they talked about vector bosons. Gell-Mann said that for several years he too had been thinking about ways to reconcile the weak and electromagnetic forces. He urged Glashow to press on, and suggested that they work on field theory together at the California Institute of Technology the next fall. "What you're doing is good, but people will be very stupid about it," he told Glashow.

"Partial-Symmetries of Weak Interactions," the paper that established Glashow's claim to a Nobel Prize, was published in the journal *Nuclear Physics* in November of 1961—one month before the author's thirty-first birthday. The paper has the dry, confident tone that characterizes the best scientific prose. "At first sight," Glashow begins,

there may be little or no similarity between electromagnetic effects and the phenomena associated with weak interactions. Yet certain remarkable parallels emerge with the supposition that the weak interactions are mediated by unstable bosons.

Next Glashow faces up to a problem that had first arisen in the work of Yang and Mills and that was still unsolvable: how much these W bosons weigh.

The mass of the charged intermediaries must be greater than [zero], but the photon mass is zero—surely this is the principal stumbling block in any pursuit of the analogy between hypothetical vector [bosons] and photons. It is a stumbling block we must overlook.

That is, Glashow simply plants a "don't know" flag on the question and turns to the rest of the theory. He argues that the theoretical problems can be resolved if one assumes not three virtual particles but *four*:

In order to achieve a . . . theory of weak and electromagnetic interactions, we must go beyond the hypothesis of only a triplet of vector bosons, and introduce an additional, neutral vector boson, Z_0 .

He confesses, "The reader may wonder what has been gained by the introduction of another neutral vector [boson]."

What had been gained was this: the neutral partner of the W^+ and W^- —the Z_0 (the current term is Z^0 , or "zee-zero")—allowed Glashow to separate the weak and electromagnetic interactions and to deal mathematically with each in turn. In Glashow's first scheme the photon had worked overtime—for both electromagnetism and the

weak force—with the result that the two tasks had interfered with each other in the theory. His second model was much neater.

In this model the weak and electromagnetic forces within the atom are like two children with an elaborate Lionel train set, each at a separate control panel: they frantically throw the switches, toot the whistle, and turn the throttle without consulting each other. The motion of the train is the result of the actions of both, and it depends from one moment to the next on what each is doing. So it is with subatomic particles. Surrounded by a haze of photons and vector bosons, the movements of particles are a synthesis of the actions of both.

The contribution of each force to the total interaction is expressed in a ratio of so much weak to so much electromagnetic, which Glashow describes in the paper. This ratio is customarily known as a "mixing angle," because of a principle from high school trigonometry that most students immediately forget: Any ratio or percentage can be expressed as a trigonometric function of some angle.

Today, to Glashow's chagrin, the mixing angle of the forces is sometimes called the "Weinberg angle." It acquired this name because seven years after Glashow's paper was published Steven Weinberg independently reinvented it. No one had paid much attention to Glashow's work; it had appeared in an unimportant journal, and if that was not enough to guarantee its obscurity, there was the fact that it was written using Schwinger's idiosyncratic symbols. In an effort to promote Glashow's work Gell-Mann reported on it in 1960 at the Rochester Conference, an important annual meeting of physicists. "I gave the first clear description of his ideas," Gell-Mann says. "The reaction was very unenthusiastic."

The reason for the lack of interest was that by adding a Z to the W particles to make the model look like a gauge theory Glashow had created a new problem having to do with weak neutral currents. Physicists had looked at millions of weak interactions and were certain that weak neutral currents did not exist. Not once, in hundreds of careful experiments, had they seen a weak interaction that might mark the passage of an uncharged vector boson.

Hundreds of experiments and millions of observations are enough to establish a fact with rocklike firmness. Unfortunately, in this case nature was playing a trick on physicists. The weak interactions of most types of particles are usually stifled by the strong and electromagnetic interactions. But strange particles can decay only by means of the weak interaction, so physicists had concentrated on strange particles in order to observe this interaction. For reasons that Glashow would not unravel for a decade, strange particles happen to be just about the only kind in which weak neutral currents do not occur; thus the years of experimental research did nothing to disprove his theory.

At the time, of course, Glashow did not know this. Like his colleagues, he believed that the data on strange particles held true for all forms of matter. To save his idea he invented a reason why the Z^0 had never shown its face. He

asserted that it must be a lot heavier than its brethren the W^+ and the W^- . To create a Z^0 experimenters would have to bring to bear much more energy than any existing accelerator could generate. No wonder the particle had never been seen. (Such theoretical gambits infuriate experimenters, by the way.)

Alas, this strategy threw the baby out with the bath water. In order to explain how weak neutral currents could exist and not be observed, Glashow had hypothesized a Z^0 so heavy that it would hardly ever put in an appearance. Thus the paper concluded, "Our considerations seem without decisive experimental consequence."

The problem of the mass of the vector bosons and the question of weak neutral currents dogged Glashow's electroweak theory from the beginning, and these difficulties were not resolved for years.

IN 1960, AFTER GLASHOW HAD FINISHED HIS PAPER ON weak interactions, he went to Pasadena to work with Gell-Mann. One of the true *enfants terribles* of twentieth-century science, Gell-Mann had entered Yale at the age of fifteen and received his doctorate at twenty-one. A polymath, he is sometimes said by his colleagues to have no particular talent for physics but to be so smart that he is a great physicist anyway. Although only three years older than Glashow, he had been on the scene almost ten years longer. By 1960 he had the run of the California Institute of Technology and was spewing out ideas at a dizzying rate. He is stocky and moves with a bullet-like determination, his shoulders thrust forward, his gaze fixed ahead. Notorious for his drive and his asperity, he is also quick and generous with praise. Like Glashow, he loves conversation. The two enjoyed each other's company and soon began to collaborate on an ambitious article that they hoped would point the way to unification.

The result—"Gauge Theories of Vector Particles"—appeared in the journal *Annals of Physics* in September of 1961. It is a curious document. Gell-Mann calls the first half "classic, a landmark," and the second half "a mess."

The first half sets up a kind of grammar for quantum field theory—a catalogue of possibilities. Drawing upon group theory (Glashow's introduction to it at Cornell, under the tutelage of Harold McIntosh, had not been a waste of time), the two physicists noted that the sets of hypothetical virtual particles described by Yang and Mills could be considered as a particular type of group. Moreover, all possible variations on this type of group had already been laid out, nearly thirty years before, by the French mathematician Élie-Joseph Cartan. Cartan had given the groups names. For example, Cartan's group $U(1)$ corresponded to the gauge field for electromagnetism—QED—and his group $SU(2) \times U(1)$ to Glashow's electroweak theory. (SU stands for "special unitary" group, and U for "unitary.")

Glashow and Gell-Mann showed that every one of the groups that Cartan had defined corresponded to a Yang–

Mills gauge field. The difficulties arose in the second half of the paper, in which Glashow and Gell-Mann tried to do something practical with the classifications borrowed from Cartan. They proposed a theory of the strong force to go along with Glashow's electroweak theory and expressed them both in terms of Cartan's groups. With this trick they sought to treat the strong and electroweak forces as Yang–Mills gauge fields. They hoped to explain those forces in the same language as electromagnetism, and link them to the only theory in elementary particle physics that by 1960 had been confirmed: QED. But the attempt was like a game of basketball and a game of hockey played in the same arena at the same time. Gell-Mann says, "We wanted to make a Yang–Mills theory for the weak interaction and one for the strong interaction. But to do this we had to have them both in the same space. And they fought each other. It was *terrible*. They would get mixed up with each other in some ghastly way, and the weak interactions would turn strong. It was *bad*, it was *sick*. Finally I said the hell with it. This one, I said, we're not going to solve now."

Glashow abandoned the effort too. He was discouraged not only by their failure to put the strong and electroweak forces into one theoretical framework but also by the still unresolved problems of the mass of the W and Z particles and the lack of experimental evidence for weak neutral currents. For almost a decade he concentrated on the strong force, consigning all his earlier work to one of the dusty piles of paper in his office.

By the early 1960s gauge field theory was in all but complete disrepute, because of the severe difficulties encountered by everyone who tried to use it. Yet Gell-Mann, Glashow, and a few others pressed on with it. During the same time that Gell-Mann and Glashow were collaborating on their paper, Gell-Mann completed an article on his own—one that created a sensation in the physics community when he circulated it in January of 1961. Although the paper was based on field theory, it had the unexpected effect of distancing physicists even further from the subject; it would take years for anyone to see how Gell-Mann's ideas could be used to write a gauge field theory.

The article was an attempt to bring some order to the profusion of new particles that experimenters had found in particle accelerators during the previous decade. By 1958 the jumble of subatomic particles had become so unwieldy that scientists at the University of California at Berkeley began to publish an almanac to keep track. The first one was nineteen pages long and discussed sixteen particles; by 1960 enough additional particles had been discovered to warrant a second, considerably larger issue, with handy reference cards for scientists to carry in their wallets. (The most recent edition, published in April of 1984, runs to 304 pages and refers to about 200 particles, not counting their various avatars and states.)

Also by 1960 a rudimentary classification scheme for particles, based on weight, had been adopted. It consisted of three categories: baryons, mesons, and leptons. "Bary–

on" is derived from a Greek word that means "heavy one," and refers, appropriately enough, to such large, massive particles as protons and neutrons. "Meson" is derived from the Greek word for "middle one," and is used for particles lighter than baryons but heavier than leptons. ("Lepton," roughly translated, means "light one.") Baryons and mesons are affected by the strong force; leptons are not.

As dozens of new particles came on the scene, theorists realized that their categories would have to be refined. Many strategies were tried, but in his paper Gell-Mann suggested the best one. In short, he argued that $SU(3)$ —another of Cartan's special unitary groups—could be the basis for a kind of periodic table of baryons and mesons. He showed that similarities among these particles—that is, almost all the particles that had been discovered by 1960—could be used to group the particles into families. Because the proton and the neutron belonged to a family with eight members, Gell-Mann named his new scheme the "eightfold way," in a joking homage to the teachings of the Buddha. (To his considerable annoyance the phrase has helped to foster the suspicion that physics has something to do with Eastern mysticism.) Just like the periodic table of the previous century, this classification of particles was of tremendous heuristic value, not only because it organized known particles but also because it suggested where new ones might turn up. For example, right away Gell-Mann asked experimenters to search for a particle that would complete one of his families. After two years of intense effort, it was found.

At first neither Gell-Mann nor anyone else could explain why particles were so much at home within $SU(3)$. Then, in 1963, Gell-Mann proposed a reason. He guessed that baryons are really combinations of three smaller particles, to which he gave the name "quarks." (Gell-Mann explains that he chose this silly-sounding name in order to avoid "pretentious scientific terminology.") He called the three quarks "up," "down," and "strange," and also proposed a corresponding triplet of anti-quarks: "anti-up," "anti-down," and "anti-strange." Baryons, he said, are made of three quarks; a proton, for instance, consists of two ups and a down clamped together by the strong force. The lighter mesons are composed of one member of the first trio (a quark) and one of the second (an anti-quark).

How did this explain why the eightfold way successfully orders particles? Gell-Mann argued that the quarks and anti-quarks that make up baryons and mesons divvy up electric charge. The up quark has a charge of $+2/3$, whereas the down and strange quarks each have a charge of $-1/3$. Thus the proton—two ups and a down—has a total charge of $(+2/3) + (+2/3) + (-1/3) = +1$. The particles in the baryon families of $SU(3)$ consist of every combination of three units of $+2/3$ or $-1/3$; the result is always an integer.

But quarks explain more than $SU(3)$'s usefulness. Gell-Mann soon realized that quarks make sense out of strangeness and isotopic spin. A particle's strangeness is given by

the number of strange quarks inside it; a strangeness of 0, for instance, means that no strange quarks are inside. Easy! And isotopic spin is determined by the number of up and down quarks in the particle; a proton, which has more ups than downs, spins on an upward axis. The values of both strangeness and isotopic spin are constant in strong interactions because, as it happens, the strong force cannot change one kind of quark into another. It can shuffle them around like cards in three-card monte, or hold them together in an iron grip, but it cannot alter the proportions of up, down, and strange.

Gell-Mann suggested that although the weak force cannot hold quarks together, it might get them to change types, or "flavors." And that trait would account for the long lives of strange particles, which can decay into ordinary particles only when the feeble weak force finally asserts itself and turns a strange quark into an up or a down.

Up, down, strange: just three quarks explained phenomena that theorists had been puzzling over for years. Nevertheless, "quarks went over like a lead balloon," as Gell-Mann says. The reason was that the fractional electric charges $+2/3$ and $-1/3$ contradicted one of the most thoroughly established rules in physics. Over the half-century during which anyone had been looking, a particle with, say, two-thirds the charge of a proton had never been spotted. Such particles simply could not exist.

Gell-Mann replied that quarks had never been seen because they cannot be seen. They are always chained together, like the hero and the heroine in the movie *The Thirty-Nine Steps*. This, too, did not go over well. Experimenters did not like the notion of something that *in principle* could not be found with the aid of their machines. Their frustration was not assuaged by Gell-Mann's serene statement that the failure to see fractionally charged quarks meant that "they exist but are not 'real.'"

Glashow adored quarks. Hypothetical particles perpetually locked inside all the particles in the nucleus was just the sort of loony supposition he thrives on, and he was determined to play with it.

IN THE SPRING OF 1964 GLASHOW RETURNED TO THE Bohr Institute. Bohr had died, but little else had changed. The institute was still full of bright young theorists talking up their ideas in tiny offices. One of these theorists was James Bjorken, who had arrived from Stanford a few months earlier. Soon Glashow hit him with his latest pet notion: namely, that there might be a *fourth* quark. He called it "charm."

Charm excited Glashow, because it arranged the universe in an elegant pattern. By then the existence of four leptons—the electron, the muon, and Schwinger's two types of neutrino—had been accepted. If a fourth quark could be summoned into existence, Glashow reasoned, then the subject matter of physics could be divided into two families.

Everyday matter consists of just electrons, their neu-

trinos, and combinations of up and down quarks: “the runts of the litter,” Glashow calls them. At high energies, however, such as those generated by particle accelerators, another family of particles appears: muons, muon neutrinos, charm, and strange quarks, which are fatter, heavier counterparts of the everyday particles. Quarks are assembled into protons, neutrons, and so forth by the strong force, whereas leptons heed only the call of the weak. By means of the weak force, all but one member of the heavier family—the muon neutrino—decay into everyday matter. As far as scientists know, the muon neutrino is stable—it does not decay. Glashow was convinced that these two families of particles, together with the virtual particles that transmit forces, accounted for all the building blocks of the cosmos. (The picture today is only slightly different. In the 1970s physicists discovered a third family, arranged just like the other two but with still heavier members.)

Glashow spent weeks thrashing around to find some justification for charm other than his certainty that God could not have been stupid enough to decree four leptons and only three quarks. He failed to come up with any, but he managed to convince Bjorken that they should send the idea off all the same. The paper appeared in the journal *Physics Letters* in August of 1964.

As it turned out, charm worked more magic than Glashow or Bjorken knew. When incorporated into $SU(2) \times U(1)$ —the group corresponding to the electroweak theory that Glashow had conceived in 1960—charm explained why experimenters had never observed weak neutral currents.

In many cases, the greater the number of ways in which a particle can decay, the more readily its decay will occur. This much is a familiar part of our world. For example, if two doors on a bus are open rather than one, twice as many people can exit at any given time. But in the quantum world such “exits” can interfere with one another, and opening an additional “door” may have the paradoxical effect of reducing rather than increasing the frequency with which particles decay.

So it is with strange particles—the kind that physicists had always used to study the weak interactions. According to the $SU(2) \times U(1)$ theory, strange particles should often emit Z^0 s and turn into ordinary particles. But experimenters had never seen any such event, let alone the number likely if $SU(2) \times U(1)$ were correct. Charm reconciled Glashow’s lovely theoretical model to this ugly experimental fact. By a quirk of mathematics (and nature), the probability that a strange particle will emit a Z^0 and become an ordinary particle and the probability that it will emit a Z^0 and become a charmed particle are almost equal. It is as if the strange particle stands irresolute between two equally tempting options and cannot bring itself to choose either. (Glashow wrote later, in an article published in *Scientific American*: “As it happened, a sign in the equation that defines [the charmed reaction] is negative, and the two interactions cancel each other.”) Thus, although weak neutral currents should be able to occur in strange particles, they

never do. Experimenters would have to look at other particles for evidence of such currents.

Unfortunately, when Glashow and Bjorken wrote their paper they didn’t see the power of charm. “There it is in black and white, and we missed it!” Glashow says, smiting his brow theatrically. “If you read my 1961 paper with Gell-Mann, you’ll say, ‘These people say the theory doesn’t work and something is missing.’ And if you read my 1964 paper with Bjorken, you’ll exclaim, ‘By God, that’s it! A fourth quark!’ But did we notice it? No. Not for six years.”

In 1964 Glashow was not even thinking about weak neutral currents. He was preoccupied by how poorly quarks fitted into field theory. If no theorist could come up with a field that would hold quarks together in a way that would explain why they were never detected in experiments, it was difficult to understand how adding a fourth quark would help matters. Troubled, Glashow gave up on charm, as he had earlier given up on $SU(2) \times U(1)$, because he didn’t know how to show that it was right. For the next seven years he published inconsequential papers, threw others away, and grew cranky. In 1966 he became a full professor at Harvard, and arrived on campus to find other members of the physics department in the same funk.

HOWARD GEORGI, A PROFESSOR OF PHYSICS AT HARVARD and Glashow’s collaborator on the Grand Unified Theory, says, “It really was an extraordinarily dull period in theoretical physics. Hardly anybody knew what they were doing—not even Steven Weinberg, who came up with one of the most important keys to the whole enterprise.”

Weinberg, Glashow’s friend in high school and college, had received his Ph.D. from Princeton. Shortly after Glashow went to teach at Harvard, Weinberg took a job nearby, at the Massachusetts Institute of Technology. A solitary thinker, Weinberg has a special gift for working with the loftiest general principles of physics. Instead of playing with specific models, the way Glashow does, Weinberg tends to chew over the ideas and conditions that shape those models. He had spent a good deal of time in the early 1960s working out an idea called “hidden symmetry” or “broken symmetry,” which has to do with the way utterly different things can come from one unobservable source.

Systems with hidden symmetry can be likened to the male fiddler crab, which has one large and one small front claw. The big claw is a threat signal—the male crab’s equivalent of a clenched fist. It is waved to scare off other males. Despite their different appearance, the two claws are generated by the same genetic material; their real symmetry is hidden from view.

In Weinberg’s scheme, although vector bosons—the particles that transmit the weak force—should, like photons, be massless, in the conditions of the real world the symmetry between vector bosons and photons breaks, and vector

bosons acquire mass. Exactly how the symmetry breaks is hardly clear. It seems to involve a mechanism featuring a special, never-seen particle—the Higgs boson—that appears, breaks the symmetry, and quickly goes away. Despite the ungainliness of such a process, Weinberg was delighted. His paper on the subject appeared in *Physical Review Letters* in November of 1967. (Ten years later he wrote, in an article published in the magazine *American Scientist*: “Nothing in physics seems so hopeful to me as the idea that it is possible for a theory to have a high degree of symmetry which is hidden from us in ordinary life.”)

Weinberg realized that adding symmetry-breaking to a variation of Glashow’s model of the electroweak force, $SU(2) \times U(1)$, would explain neatly how vector bosons could fit into a gauge theory and still have mass. Yang and Mills had shown that the virtual particles associated with a gauge theory could not have mass, but experimenters had pointed out that if such massless particles existed, they would long since have been produced in laboratories. Glashow had been unable to resolve the contradiction, and had simply asserted that vector bosons acquire mass in some unknown way. In his paper Weinberg argued that Glashow’s W and Z particles get their mass through spontaneous symmetry-breaking and the action of the Higgs boson.

The paper was elegant and the accomplishment major, but nobody, not even Glashow, gave it much notice. A year later, as part of a grab-bag article inventorying possible ways to unify the weak and electromagnetic interactions, Abdus Salam published an almost identical model. He incorporated hidden symmetry into a theory similar to Glashow’s $SU(2) \times U(1)$, which he had created with a colleague, John Ward, in 1964. And his paper was neglected too. Those physicists who happened upon Weinberg’s or Salam’s model did not believe that the theory was renormalizable; further, the models still predicted weak neutral currents, and such currents still had not been observed. Neither Weinberg nor Salam saw that charm would do the trick.

A more egregious example of missed connections occurred in 1970, when Glashow, working with two Harvard postdoctoral fellows, John Iliopoulos and Luciano Maiani, at last realized that charm solved the problem of weak neutral currents, but failed to link it to $SU(2) \times U(1)$.

Glashow, Iliopoulos, and Maiani argued that charm must exist in order for $SU(3)$ —Gell-Mann’s description of particles responsive to the strong interaction—to be reconciled with the weak interaction. It is difficult to overstate the audacity of such an argument: Glashow and company were contending that a new state of matter had to exist to make two as yet unproven theories fit together in an aesthetically pleasing way.

Glashow presented the new work on charm to an audience at MIT that included Weinberg. He recalls, “After the talk, Steve said, ‘What you’ve done is very interesting,’ but he never sensed the relevance to his paper. We

weren’t aware of Steve’s paper either. We didn’t refer to it—not out of malice but out of sheer ignorance. There we stood, each with half of the puzzle solved, and *nothing happened*.” Glashow takes a disgusted pull on his cigar. “What on earth could I have been *thinking* about?”

IN 1971, AFTER ALMOST FIFTEEN YEARS OF WORK, GLASHOW was unable to point to a single major success. In a sense, he had bet his career that gauge theory would pan out; most physicists were convinced that it would not. Even Weinberg, unable to renormalize his own electroweak model, seemed to be throwing in the towel.

Depressed, Glashow went to a conference in Marseilles, which John Iliopoulos also attended. They stayed on for a few months and busied themselves with an attempt to renormalize gauge field theory—a purely mathematical task that had stumped physicists since Yang and Mills had written their paper, in 1954. Glashow’s forte as a physicist is not mathematics—“I think in pictures, not equations,” he observes—and he found the work little to his liking. He says, “There we are, laboriously canceling out infinities, when this guy Veltman comes up to us. And he says, ‘My young student has solved the problem of renormalizability of gauge theories. All the work you’ve done for the past year is a waste of time!’ And he was right. His student had spontaneously re-created the whole $SU(2) \times U(1)$ theory, and renormalized it to boot.”

The Dutch physicist Martinus Veltman was one of the few who had clung unswervingly to quantum field theory. He had holed up at the University of Utrecht, in Holland—the only particle physicist in residence—and had taught himself the peculiar mathematical techniques that he thought would be necessary to vindicate the theory. In 1969 he acquired a graduate student named Gerhard ’t Hooft. “I gave him a piece of the problem,” Veltman says. He gave it to the right person, for ’t Hooft used Veltman’s mathematical tools to construct two brilliant papers. The first demonstrated how Yang–Mills fields could be made renormalizable; this work had already been done by Veltman and others, but few physicists knew or cared, because it did not resolve the mass problem. The second paper added spontaneous symmetry-breaking, solving the mass problem, and an $SU(2) \times U(1)$ model of the weak interactions to Yang–Mills, and showed how the whole thing could be renormalized.

Incredibly, when ’t Hooft developed his ideas, he had read nothing by Glashow, Weinberg, or Salam, and only some of the literature on spontaneous symmetry-breaking. He reinvented the entire body of work (except charm) on his own. Realizing that his student had come up with something important, Veltman quickly alerted the physics community.

When Glashow returned to the United States in the fall of 1971, physicists at Harvard and MIT gathered to hear about ’t Hooft’s proofs, and at first they were baffled. But as weeks passed, the realization spread to departments all

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over the country that a breakthrough had finally occurred. Not only $SU(2) \times U(1)$ but also every other gauge model based on Cartan's groups suddenly made mathematical sense. The physicists at Harvard immediately became advocates of gauge theories; the lights of Lyman Hall burned late into the night. Glashow was jerked out of his doldrums, to embark on the most productive period of his career. He churned out paper after paper exploring the implications of 't Hooft's work.

(He also managed to find time to court the woman who eventually became his wife. According to Glashow, he met her in September of 1971, at the home of the mathematician Daniel Kleitman. Glashow was asked to help Kleitman's sister-in-law, Joan Alexander, shuck corn. She was twenty-eight, recently divorced, and had two small children; Glashow was thirty-eight, and fond of children. In February they became engaged, and in May they married. Besides Joan's children, they now have two of their own.)

During the early 1970s $SU(2) \times U(1)$ and charm received unexpected support. First, neutral currents were discovered—in 1973, shortly after experimenters had stopped looking for them exclusively in strange particles and had turned to neutrinos. Their existence was hard to understand unless one accepted charm, as Glashow did. Second, a successful gauge field theory of the strong force was put forward by Weinberg, on the East Coast, and several physicists on the West Coast, including Gell-Mann. It said that the strong force, like electromagnetism, is associated with a charge. The charge is not electric, but has to do with a quality that has been named "color" (though it has nothing to do with ordinary colors). To underline the new theory's similarities to QED, Gell-Mann christened it "quantum chromodynamics," or QCD—*chroma* being the Greek word for "color." (Although QCD is quite different from Gell-Mann's earlier $SU(3)$ theory, which it supplants, it is described by the same mathematical group. Confusingly, physicists have used the term $SU(3)$ for both that earlier theory and QCD; hereafter, in this article, it shall refer only to QCD.)

Field theorists had been slow to accept quarks, because it was hard to imagine a Yang-Mills field confined enough to keep quarks always glued together into mesons and baryons. The gauge field of QCD works backward: the farther apart quarks are within a particle, the harder it is to separate them. Ultimately the effort required becomes so great that if one tries to tug loose a single quark, the energy that must be brought to bear creates a new quark and an anti-quark. The anti-quark bonds to the quark that has been freed, creating a meson; the new quark pops right back into the original particle, leaving it with the same number of quarks as before.

"The whole process is rather hard to visualize," Glashow says, laughing. "It's . . . ah, a bit counterintuitive."

Why experimenters had not seen weak neutral currents when they looked at strange particles but did see them when they looked at neutrinos was one of the most pressing problems in physics in the mid-1970s. Many scientists

had hoped that a theory of quarks and the strong force would somehow solve the puzzle. They were disappointed. QCD had nothing to say about weak neutral currents. But charm did, Glashow claimed. Moreover, the fourth quark would provide a bridge between QCD and the electroweak theory, confirming both and paving the way to unification. Without charm, Glashow said, the theories could not be reconciled, either with each other or with experimental results.

"A lot of people were doubtful about the whole thing," Nicholas Samios, the director of Brookhaven, says. "It came together very fast, and out of left field. Shelly said that $SU(3)$ and $SU(2) \times U(1)$ had to fit together to make $SU(3) \times SU(2) \times U(1)$. And he said that the way to join them was charm."

In April of 1974 Glashow spoke before a conference of meson specialists that was held at Northeastern University, in Boston. In a speech titled "Charm: An Invention Awaits Discovery" he explained to the assembled experimenters that by virtue of the mechanism described in the Glashow-Iliopoulos-Maiani paper, a fourth quark existed, even though there was still no evidence for it. He set down his reasoning on a blackboard, cheering up some in the crowd when he botched the mathematics the first time through. Undeterred, Glashow challenged the meson physicists in the room: they were rightfully the ones to discover charm, because they were concerned with quarks, he said; but because they weren't looking for it, charm would be found by "outlanders"—other sorts of experimenters. By the time of the next meson conference, Glashow said, "there are just three possibilities: One, charm is not found, and I eat my hat. Two, charm is found by [meson specialists], and we celebrate. Three, charm is found by outlanders, and *you* eat *your* hats."

Two months later Iliopoulos threw down the gauntlet before the Seventeenth Annual International High Energy Physics Conference. An excellent orator, Iliopoulos delivered a tub-thumping defense of $SU(3) \times SU(2) \times U(1)$. There are, he asserted, two fundamental classes of matter: quarks and leptons. There are four particles in each class, shuffled neatly into two families. Electromagnetism, the weak force, and the strong force are covered by two gauge theories consistent with each other, the whole being described in a grand synthesis called $SU(3) \times SU(2) \times U(1)$. The synthesis demands that charm exist, Iliopoulos said, and he bet the assembled physicists bottles of fine wine that the fourth quark would be found before they met again. At stake, he said, was more than Glashow's model. At stake was the validity of quantum field theory.

ALTHOUGH GLASHOW AND ILIOPOULOS DID NOT KNOW it at the time, their bets were safe. In fact, physicists at universities in Tokyo and Yokohama, led by Kiyoshi Niu, had found evidence of charmed particles three years before. Unfortunately, their paper was published as a letter to the editor in a journal that, though pub-

lished in English, has few readers outside of Japan. (One American scientist calls it "a graveyard of great ideas.") Moreover, although the Japanese knew that their discovery was important, they had never heard of charm, and they referred to their finding as a "new particle"—the "X." Niu and his colleagues had found the X by analyzing the highly energetic bursts of particles created by cosmic rays; most European and American physicists considered this method so antiquated and unreliable that they paid no attention to Niu's efforts to publicize his result. Hence Niu and his team played no role in establishing the validity of charm, and they got none of the credit for its discovery.

Nor did a second team of experimenters, at Brookhaven, that was turning up evidence of charm even as Glashow spoke. The first definitive evidence was published seven months later by two different teams—another at Brookhaven, and one at Berkeley and Stanford. When all was said and done, it took one more year and a fifth sighting before charm was accepted.

The laborious vindication of charm is an example of the difficulty of proving ideas in quantum field theory. Subatomic particles cannot be seen directly, because of the Uncertainty Principle, which rules out the possibility of "seeing" a particle in a particular place at a particular time. Moreover, most subatomic particles are so unstable that they must be created by huge machines, called particle accelerators, after which they live only minute fractions of a second before mutating into something else. The difficulty is magnified in the hunt for quarks, because quarks never appear by themselves, solitary and easily distinguishable; they are always part of a crowd.

Finding charm was thus much harder than looking for the proverbial needle in the haystack. In this case, experimenters first had to make the needle, after which, of course, it vanished. Furthermore, they were looking for just a piece of the needle—a piece that they could never see directly.

Confronted with such obstacles, experimenters have developed a variety of ingenious mechanisms to persuade particles to reveal their doings. These devices do not perform the impossible task of making particles visible; rather, they get them to leave visible traces.

A particle accelerator (or "atom smasher," as it is sometimes called in newspapers) is a big machine that breaks atoms apart and sends their protons or electrons flying. The stream of particle "bullets" thus created is shunted out of the accelerator through various channels into special components known as detectors. There the protons or electrons slam into other particles or into the nuclei of atoms. The pieces fly all over the place, and scientists try to measure their trajectories for clues to what is going on. (The whole process has been likened to firing a gun at a watch to see what is inside.) Because accelerators house more than one detector, a number of groups can perform experiments simultaneously. Detectors have become increasingly sophisticated over the years. By the early 1970s the most sensitive design was a chamber in which a parti-

cle traveling through a liquid leaves a wake of minute bubbles, which are recorded on film.

The first sighting of charm in the United States was made in a bubble chamber by a team of scientists at Brookhaven headed by Nicholas Samios. In 1974 Brookhaven had just finished building one of the largest bubble chambers in the world. Ten feet tall, the bright silver-colored chamber, ringed with wire and filled with liquid hydrogen, pointed skyward like a fat rocket. Surrounding the vat was a network of shiny cooling pipes and insulation to keep the hydrogen cold. A platform about fifteen feet above the ground allowed scientists access to three cameras mounted at portholes at the top. At the base of the detector a hydraulic jack rammed a thousand-pound piston in and out once every two-and-a-half seconds, creating the pressure at which particles will leave bubbles.

"It was a brutal thing," Robert Palmer, a member of Samios's team, says. "Standing on top of the machine while it was in operation was a terrifying experience. The piston moves with incredible force, and it's *heavy*. The whole assembly was bolted to the ground, but despite that the thing would jump every time—"

"—and the *ground* would shake," Samios cuts in. "When you came to work and drove in the parking lot, you could always tell when the experiment was running. You could feel the vibrations a hundred yards away."

Samios designed an experiment to create neutrinos from one of the streams of protons generated by the laboratory's accelerator, fire these neutrinos into the chamber, and watch for collisions between them and hydrogen nuclei. Such collisions would be extremely rare; neutrinos are affected only by the weak force, and can therefore slip through matter like greased pigs, touching nothing and being touched by nothing. In the time it takes to read this sentence, thousands of neutrinos from the sun will pass through the page and continue into the earth without a trace.

Brookhaven approved the procedure in August of 1973. Glashow, who was then a consultant at the laboratory, proposed to Samios shortly thereafter that the new experiment would be a good way to look for charm. A speeding neutrino might interact weakly with a proton still in the chamber—that is, a W^+ would pass from one to the other. Upon absorbing the W^+ , one of the down quarks inside the proton would change into a charmed quark, and for a fraction of a second— 10^{-13} seconds, according to the theory—a charmed baryon would come into existence. The charmed baryon would not survive long enough to be photographed. But when it decayed (and the charmed quark changed again, this time into a strange quark), it would become a strange baryon, called a "lambda." The lambda, too, would eventually disintegrate into other particles, but it would hang around long enough to be detected.

Samios would be able to tell that the lambda was the artifact of a charmed baryon, rather than of the neutrino's initial collision, because, as it happens, neutrinos cannot produce lambdas directly. Glashow explained that if Sa-



mios could find an event in which a neutrino had created a lambda, this would constitute strong evidence of charm's existence.

The experiment started in January of 1974. Except for occasional breaks for maintenance, from then until March of 1975 the particle accelerator shot a billion neutrinos into the bubble chamber every two-and-a-half seconds. Twenty-four hours a day, seven days a week, the three cameras atop the detector snapped pictures, capturing on 70mm film whatever was inside.

By the end of the run Samios's team had taken more than 500,000 pictures. According to Glashow's theory, interactions between a neutrino and a proton should have been recorded on about 2,000 pictures—or less than one percent. The problem now was to find the right ones, a remarkably time-consuming process.

Brookhaven hired nonscientists to do the job. Mostly housewives with families who needed extra income, they worked round the clock, three shifts a day, at specially constructed projectors that flashed the images onto white tabletops. The scanners, as the women were called, copied the tracks of potentially interesting events into sketchbooks and measured the various angles and lengths.

When a picture taken inside a bubble chamber is blown up on a screen, the result can be astonishingly lovely: white lines skirl across a gray field, intersecting, branching out, and looping, like the epicycles in a Ptolemaic drawing of the heavens. Milda Vitols, who supervised the scanners, showed them how to decipher the tangle. Each type of particle leaves its own characteristic track—or "signature"—in the general snarl, and with experience anyone can learn to read these signatures. Electrons, which are quite light, produce faint tracks as they zip through the hydrogen at nearly the speed of light. Protons, which are almost two thousand times more massive than electrons, and which travel more slowly at the energies that Samios had employed, leave lines like thick pen strokes across the picture. Being electrically neutral, a lambda would not leave tracks, but its decay would yield two particles whose tracks would be visible. Vitols told the scanners to look for two rays appearing out of nowhere and shooting off in a V. (This would be the decay products of the lambda.) If the scanners saw a V, she said, they should look to see if the vertex pointed back to the vertex of another set of tracks. (This would be the locus of the initial collision between the neutrino and the proton.) If they found a second group

of lines near the first, Vitols said, the scientists would be very excited, because the configuration would mean that their quarry, the lambda, had glided silently between those two points for the brief flicker of its existence.

On May 30, 1974, Helen LaSauce, a former switchboard operator and the mother of three, advanced her scanning machine to frame 6,967 of roll 27 and spotted an obvious collision. A pair of tracks parted from one vertex, and close by five tracks led away from another. It took Samios, Palmer, and the other members of the team seven months to exclude every possible source of experimental error—a task that was complicated by their inexperience with the new bubble chamber and by the continuing lack of a similar event with which to compare the one that LaSauce had found. Even when they had finished, they were reluctant to assert that they had discovered a new state of matter on the basis of one event in an untried detector, so they waited a bit longer—in vain, it turned out—to see whether at least one more had occurred.

WHILE SAMIOS DOUBLE-CHECKED HIS INCONCLUSIVE result, two other groups of experimenters came up with definitive evidence of charm. Whereas Samios had found a charmed baryon, these teams came up with mesons made from charmed quarks. One team, headed by Samuel C. C. Ting, of MIT, drew protons from the same accelerator at Brookhaven that Samios and Palmer had used. The other, headed by Burton Richter, followed a different procedure at the Stanford Linear Accelerator.

Ting says that when he proposed his experiment, in January of 1972, he had never heard of charm. In fact, he is proud—to the point of arrogance, his detractors say—of carrying on his work without regard to what the theorists are doing. “There are two kinds of experimenters,” he says. “One does what the theorists tell them to. The others follow their own ideas. I am of the second kind. Now, I’m happy to sit down and eat Chinese dinner with theorists. But to spend your time doing what they say to do is wasted effort.”

Ting has spent much of his career studying pairs of electrons and positrons, which are easily controlled in experiments and which yield useful information about the characteristics of other, related particles. (A positron is the positively charged counterpart of an electron.) Ting used the Brookhaven accelerator to smash protons into atomic nuclei, because this process often produces showers of mesons. Although some types of mesons decay too quickly to be directly observed, they can be studied by means of the products of their decay: electron-positron pairs. Ting wanted to see if new varieties of mesons could be created at higher energies than had been examined before. Early in the fall of 1974 he was told that the machine was producing many electron-positron pairs at such higher energies—about 3.1 billion electron volts, or three GeV. (An electron volt is a small unit of energy used by particle

physicists, and one billion electron volts equals one GeV.) After weeks of cross-checking, Ting was finally prepared to announce that he had come across a new particle. He named it the “J particle,” because “J” is the symbol in physics for the electromagnetic current.

In the meantime, Richter’s team found the same particle by yet another method. Their experiment used a new accelerator that causes direct collisions between electrons and positrons; it also employed a new detector to review the resulting debris. Usually such debris consists of muons, but at the right energies various types of mesons can be produced, which make themselves known by the artifacts of their decay. When Richter’s team discovered a surge in the number of these artifacts, they knew that they had discovered a new meson. They christened it the “psi.”

The particle that Ting and Richter discovered is now called the “J/psi” by everyone except Ting and Richter, who refer to it as the “J” and the “psi,” respectively. The J/psi electrified the physics world, for it wasn’t immediately clear how the new meson fit into any of the models. Ting had found 242 events, and he was told that theorists had as many ways to explain the new particle. In December, a month after the discovery, he met Glashow at Brookhaven and heard that the J/psi was probably made up of a charmed quark and a charmed anti-quark. It was the first time that Ting had seriously considered the fourth quark, and he liked the idea, but he also liked some of the 241 others. Impatient with theoretical pettifogging, he turned to other work.

Richter, on the other hand, was aware of charm, but he also knew that if charmed quarks existed, they should combine with other, noncharmed quarks (specifically, anti-quarks) to form mesons. A year and a half went by before one of Richter’s collaborators, Gerson Goldhaber, of Berkeley, found the mesons.

That data convinced even the most diehard skeptics: charm had been confirmed, by Glashow’s “outlanders.” In Paris, Iliopoulos received his wine. And at the next meson conference the scientists ate candy Mexican hats. “They were extremely peppery—not a pleasant candy,” Roy Weinstein, the physicist who presided over the meeting, says. “But everyone ate them with relish, and agreed that Shelly’s prediction had been magnificent.”

AT THE SAME TIME THAT THE EXPERIMENTERS WERE confirming $SU(3) \times SU(2) \times U(1)$, the prospect of a Nobel Prize began to creep into the minds of the physicists involved. Established through a posthumous bequest by the Swedish explosives manufacturer Alfred Nobel, the prizes are administered by Swedish academics who have a reputation for being extremely cautious. (For example, no Nobel citation has ever mentioned quarks explicitly, evidently because the Swedish Royal Academy is reluctant to accept the idea.) By the terms of Nobel’s will, no award in a given category may be shared among more

than three people, and no discovery may be honored twice.

Many, if not most, prizewinners have an ambivalent attitude toward the Nobel, which brings unwanted attention even as it gratifies the ego and the purse. (A single winner can receive \$150,000 or more.) Few physicists would say publicly that one of their colleagues who had won a Nobel had not merited it, but most would agree that the award process has slighted some deserving scientists. Selecting the Nobel prizewinner is relatively easy when one person makes a discovery with little or no help, as Planck, the winner in 1918, did when he proposed the idea of the quantum. The sudden coming together of $SU(3) \times SU(2) \times U(1)$ in the early 1970s, however, was a completely different situation. It represented the abrupt and largely unexpected fusion of the work of many researchers. Moreover, because this fusion vindicated field theory, which had been out of favor for years, few of the prior steps— $SU(2) \times U(1)$, for example—had been awarded prizes.

There was considerable scuttlebutt about who the prizewinners should be. Yang and Mills had started gauge field theory in 1954, but Yang had won the prize in 1957 for something else. Schwinger, too, had already received a Nobel, for demonstrating how to renormalize QED. The academy had also given one to Gell-Mann, not for quarks but for “discoveries concerning the classification of elementary particles.” Glashow had first put $SU(2) \times U(1)$ together, but his formulation had been incomplete; Salam and John Ward had produced the same model later. Several British and Belgian theorists had developed the principles of broken symmetry, which Weinberg had subsequently added to $SU(2) \times U(1)$. A similar notion had been presented by Salam the following year, but it was buried in an article that Salam had not had time to prepare fully. Later, ‘t Hooft had renormalized the theory with Veltman’s help—a great accomplishment, but one that some scientists felt was in the realm more of mathematics than physics. The physicists Oscar W. Greenberg, Moo-Young Han, and Yoichiro Nambu had had the first inklings of QCD; collaborating with Gell-Mann, the German scientist Harald Fritzsch had also made contributions, as had others, such as, again, Weinberg. This list does not even include the experimenters. In the charm experiments alone, there had been Kiyoshi Niu and his team, who had, after all, seen the first charmed event even though they had not recognized it as such; Samios and his team, who had been the first to find charm and call it that but who had published fourth; Ting and Richter, each with his own roster of collaborators; and Gerson Goldhaber, whose results had convinced the physics community that the fourth quark exists.

The Swedish Royal Academy of Sciences laid to rest some of the speculation when it gave the prize in 1976 to Ting and Richter—not for the discovery of charm, of course. The judges cited only their “pioneering work in the discovery of a heavy elementary particle of a new kind.” The award was not universally popular. It is easy to

find experimenters who dislike Ting, despite his eminence. And it is equally easy to find people who will say that a member of Richter’s team somehow learned of Ting’s discovery and duplicated it before it could be announced. (Both Richter and Ting say that this did not occur.)

After 1976, discussion concentrated on the theoretical side, and the field narrowed. From the first, Weinberg was a likely candidate. Although his 1967 paper had been ignored initially, he had been lucky enough to have it extensively discussed by ‘t Hooft. Salam had been less fortunate. His work had been similar, but it had been published a year later in the proceedings of an unimportant Swedish conference. Moreover, the article consisted simply of a transcript of the lecture Salam had given, and the correct electroweak model, with symmetry-breaking, was not stressed. (Salam explains that he was too busy setting up a new institute of physics in Trieste to revise and develop his work.) For a while physicists had referred to the “Weinberg model” of weak interactions, but then Salam had sent a letter to a number of scientists asking them to call it the “Weinberg–Salam model,” and Weinberg had gracefully accepted the change. When the Nobel committee followed its annual practice of asking prominent physicists and former prizewinners for their recommendations, at least two are said to have made sure that the committee knew of Glashow’s contributions. Others argued that ‘t Hooft should get a share.

The politicking had personal consequences, the most severe of which was the unraveling of the decades-long friendship of Glashow and Weinberg. The subject is so sensitive that few physicists are willing to discuss it. Weinberg himself, who is now at the University of Texas at Austin, politely but firmly refused our requests for an interview in connection with this article.

“Steve and Shelly are complete opposites,” someone who knows both well says. “Steve is a royalist, Shelly a revolutionary anarchist. Steve works best by himself, Shelly works best with others. He’s a futzer. He arrives in the morning with four or five wild ideas, most of them wrong, and expects other people to tear them apart. Steve is sensitive and private, while Shelly is gregarious and tends to view a person like Steve as an anthill to poke sticks down. It would be surprising if a tension *hadn’t* developed between them sooner or later.”

By the late 1970s the two had become openly hostile. Weinberg wrote a review paper that managed to discuss the history of charm without once referring to his former classmate. Annoyed, Glashow took to telling people that *he* was the originator of the Weinberg angle and that its correct name was the “weak mixing angle.” (“It *does* begin with the same letter,” he says.) To the uninitiated this sort of slight might seem trivial, but scientists rely on references to their work in articles and footnotes to sustain their reputations. Glashow reports with some delight that when he spoke at Stockholm in 1978, a year before he won the Nobel, a wizened member of the Swedish Academy ap-

proached him and said (here he does a surprising, rather good imitation of a decrepit Scandinavian academic): "Jaa . . . thees Weinberg enkle, is not same as *yoor* enkle from sixty paper, ja?" The speech that Glashow had just given had included an exploration of the possibility that gauge theory might be wrong. Talking to an audience of Nobel Prize-giving Swedes about a topic that could jeopardize the prize for everyone involved is classic Glashow ("He proposes ideas just to get other physicists annoyed," Georgi says, laughing.) Weinberg is said to have called Glashow the night before to argue that the speech was irresponsible.

When the 1979 Nobels were announced, the prize for physics was bestowed in equal shares upon Glashow, Salam, and Weinberg, "for their contributions to the theory of the unified weak and electromagnetic interaction between elementary particles, including *inter alia* the prediction of the weak neutral current." The award for the electroweak theory was interpreted by most as a seal of approval for $SU(3) \times SU(2) \times U(1)$ as well, because the confirmation of charm's existence had proved that $SU(2) \times U(1)$ does not make sense *without* $SU(3)$.

The prize somewhat eased the tension between Glashow and Weinberg, and in the final footnote of the printed version of Glashow's award speech he thanked his "high school friends Gary Feinberg and Steven Weinberg for making me learn too much too soon of what I might otherwise have never learned at all."

THE WINDOWSILL OVER THE SINK

You're back from a long trip
and promise yourself
that it will never be cluttered
again. Yet you see it grow
its inhabitants almost by stealth:
a horse chestnut, votive candles,
paper clips and safety pins,
the accumulation gathering around
the aspirin bottle. Then the cup
with the broken handle, the bird's nest
found on a walk, pinecones,
matchbooks, coupons offering
ten cents off on a Mercedes.
The old life is re-entered this way
and begins to crowd around you
with its clutter showing again that
you can keep everything but promises.

—Vern Rutsala

PHYSICS TEXTBOOKS PRESENT IDEAS IN A CLEAR, LOGICAL way, and move from simple premises to their more complex corollaries. But physicists work in a different way, and their handiwork—the science—advances in fits and starts. At any given time thousands of ideas are discussed, and hundreds of experiments are performed, but only a few seem truly significant a few years later. It is often impossible to predict when an article is published whether or not it will be important years later; revolutionary approaches can be lost in the thickness of conference proceedings and rediscovered by scientists when the conference is only a dim memory; brilliant experiments may lie unnoticed in journals and Ph.D. theses; good ideas may be put forward and forgotten, or derided and dismissed because the field is not ready to absorb them.

Amid the tumult of the discovery of charm, a paper that used $SU(3) \times SU(2) \times U(1)$ as a base to go far into the unknown had been published to little serious notice; it was so radical that most physicists had simply scoffed at it. In 1973, months before Iliopoulos's impassioned proclamation of $SU(3) \times SU(2) \times U(1)$ and the discovery of the J/ψ , Glashow and Howard Georgi had produced the first Grand Unified Theory. Like $SU(2) \times U(1)$, the GUT was ignored for years. To believe that it was plausible, one had to believe in the standard model. To believe in the standard model, one had to believe in charm. And at the beginning of 1974, when the first GUT was published, the believers in charm included Glashow, Georgi, and barely enough other scientists to fill a small room.

Georgi is thirty-seven now—"getting senile," he says—but in 1973, when he collaborated with Glashow on the GUT, he was a third-year postdoctoral fellow at Harvard. Glashow thought their talents were perfectly complementary. Sitting in his office he would spin out one idea after another, and snarl in mock fury as Georgi shot them down. "He comes at you in the morning with ten ideas he's had since the day before," Georgi says. "You have to tell him what's wrong with them, which means you have to have this kind of automatic computer in your brain to spit back responses. But if you can't figure out what's wrong with an idea right away, then you go to work on it."

Although to outsiders the collaboration can seem anything but harmonious, Glashow and Georgi have enjoyed it immensely. In 1973 and 1974 alone they wrote four important papers together, one of which set out the first Grand Unified Theory.

When $SU(2) \times U(1)$ was coming together, Gell-Mann says, he was fond of needling his colleagues by informing them that it was not a fully unified theory. "It's a *mixing*," he says. "That's why you have a mixing angle, because the electromagnetic and weak forces are not really unified. A truly unified theory would show how both the weak and the electromagnetic forces are different aspects of the same interaction."

The notion that the weak and electromagnetic forces could be *directly* unified occurred to Glashow on the day, in October of 1973, when he first heard about $SU(3)$, the

gauge theory of quantum chromodynamics. He saw immediately the rough outline of the theory that he was looking for. He needed to find yet another group—one large enough to contain both $SU(3)$ and $SU(2) \times U(1)$. Such a group would permit him to put quarks and leptons into one family and would allow for a unified description of the strong, weak, and electromagnetic forces. The obvious difficulty was that these forces didn't *look* as if they could be unified, inasmuch as the strong force is a hundred times more powerful than electromagnetism, and both are enormously stronger than the weak interaction. Somehow the differing strengths would have to be reconciled.

The relative strength of a force between two objects depends in part on such variables as their masses and the distance between them. Above all, it depends on the "coupling constant," an abstract number whose physical basis need not be explained here. Each force in the universe has a coupling constant, which has been measured by experiment and describes that force's absolute strength.

To produce a truly unified theory of the strong, weak, and electromagnetic forces, one would have not only to find a group to contain all three but also to link them by means of a single coupling constant. Glashow laid all this out for Georgi, who is an expert model builder, and the two sat down to work out a theory.

Georgi remembers the day well. True to form, he and Glashow spent the afternoon arguing furiously about how to proceed. Unable to hammer out a solution, each left Lyman Hall in some distress. Later that evening Georgi sat down at his desk at home to work on the problem further.

"I first tried constructing something called the $SO(10)$ model, because I happened to have experience building that kind of model," Georgi says. "It's a group in ten dimensions. The model worked—everything fit neatly into it. I was very excited, and I sat down and had a glass of scotch and thought about it for a while.

"Then I realized this $SO(10)$ group had an $SU(5)$ subgroup. So I tried to build a model based on $SU(5)$ that had the same sort of properties. That model turned out to be very easy too. So I got even more excited, and had another scotch, and thought about it some more.

"And then I realized this made the proton, the basic building block of the atom, unstable." If the proton was unstable and would eventually fall apart, so would all atoms—and thus all matter, Georgi realized. If the model on his scratch pad was true, then the universe would ultimately disintegrate. He says, "At that point I became very depressed and went to bed."

The next morning he arrived in Glashow's office with "some good news and some bad news," he recalls. The good news was $SU(5)$, of course, and the bad news was proton decay. His colleague didn't take the bad news hard. "It wasn't shattering," Glashow says. "I mean, we know the sun will burn out in a few billion years. This is *known*. It's a *fact*. Spaceship Earth and all that—poof! That matter falls apart a long, long time afterward is scarcely an upsetting idea. It's bad enough as it is."

Glashow *was* troubled by the question of why the protons in the universe had not already decayed, given $SU(5)$'s implication that they could have. The two men raced upstairs to the Harvard physics library to look up what experimenters had found to be the minimum lifetime of the proton. The figure was 10^{27} years, or "1" followed by twenty-seven zeros—trillions of times the present age of the cosmos. Georgi and Glashow sat down to figure out how to make the theory predict that protons would hold out that long.

"My immediate reaction was that we had to make the virtual particles that bring about proton decay very heavy," Glashow says. "That meant they wouldn't appear very often. This we could do thanks to Steve, who had taught us in his 1967 paper how to give the intermediate vector particles a big mass. Only in our case they had to have a *much* bigger mass—a thousand trillion times bigger than anything that had ever been seen." In fact, the proton-decay particle was later calculated to have a mass of almost a billionth of a gram—nearly heavy enough to be weighed on a scale.

Glashow loved the idea of monstrous subatomic particles. "It was another way for him to throw rocks at the establishment," Georgi says. "Nobody we knew had ever even *talked* about elementary particles that heavy. Not even within twelve orders of magnitude of that."

GEORGI AND GLASHOW SENT $SU(5)$ TO *PHYSICAL REVIEW Letters* in January of 1974. They had decided not to be shy about what they were doing, and had given the paper the most imposing name they could think of: "Unity of All Elementary-Particle Forces." Only three and a half pages long, the paper linked nearly all of the significant discoveries in subatomic particles that had been made in the past quarter-century. The mathematical tools it employed came from group theory and Yang and Mills; articles by Gell-Mann, Glashow, 't Hooft, Salam, Weinberg, and others were cited. Quarks, symmetry-breaking, and gauge fields all played a role.

Georgi and Glashow opened with a fanfare as brassy as that in any recent scientific paper:

We present a series of hypotheses and speculations leading inescapably to the conclusion that $SU(5)$ is the gauge group of the world—that all elementary particle forces (strong, weak, and electromagnetic) are different manifestations of the same fundamental interaction involving a single coupling strength. . . . Our hypotheses may be wrong and our speculations idle, but the uniqueness and simplicity of our scheme are reasons enough that it be taken seriously.

They then proceeded to lay out the ground rules, acknowledging their sources. (The italics are Georgi and Glashow's.)

Our starting point is the assumption that *weak and electromagnetic forces are mediated by the vector bosons of a gauge-invariant theory with spontaneous symmetry break-*

ing. A model describing the interactions of leptons using the gauge group $SU(2) \times U(1)$ was first proposed by Glashow, and was improved by Weinberg and Salam, who incorporated spontaneous symmetry breaking.

In the next paragraph they introduced what was then little more than a favorite hypothesis of Glashow's: charm.

To include [baryons and mesons] in the theory, we must use the Glashow-Iliopoulos-Maiani . . . mechanism and introduce a fourth quark . . . carrying charm.

In the fourth paragraph they invoked QCD. They now had the entire standard model, which was then years from being demonstrated in experiment.

Thus, we see how attractive it is for strong, weak, and electromagnetic interactions to spring from a gauge theory based on the group $F = SU(3) \times SU(2) \times U(1)$. Alas, this theory is defective in one important respect: It does not truly unify weak and electromagnetic interactions. The $SU(2) \times U(1)$ gauge couplings describe two interactions with two independent coupling constants; a true unification would involve only one.

Next Georgi and Glashow hunted through the list of groups that Cartan had compiled decades before, and came up with three that could provide the basis for a truly unified electroweak theory. These three had already been used in models made by Weinberg and, later, Georgi and Glashow. None was found to be reconcilable with $SU(3)$. This allowed the writers to conclude, with some pleasure, "We see we cannot unify weak and electromagnetic interactions independently of strong interactions." They then declared themselves forced to consider the "outrageous possibility" that a single group could account for all three. Methodically they set down all of the groups of sufficient size. As it happens, there are nine. One by one, these were eliminated, except the last, which was, of course, $SU(5)$ —the basis for the model that Georgi had created over shots of scotch a few months before.

The last half page of the paper was devoted to characterizing $SU(5)$ and its implications, which are multifarious. To start, saying that forces are equivalent implies a similarity among the particles with which they interact. Therefore, within this Grand Unified Theory (as well as within each variant that has been proposed since) quarks and leptons are kith and kin. Particles within a family can decay into one another, and thus Georgi and Glashow had to postulate the existence of a brand-new, never-before-seen force that would allow for just that possibility. They named this force the "superweak," and suggested that it is mediated by a new set of extremely heavy vector bosons, which Glashow has since nicknamed "ponderons," or "vector basketballs." These particles weigh too much to be emitted often, but when a quark does emit such a particle, that quark turns into a lepton. If the quark is inside a proton, the proton will fall apart. The pieces of the proton will, in turn, eventually decay into photons, which will ultimately traverse an utterly empty space. Because protons are a nonrenewable resource, the universe will

end as it began, with light. Eventually the light will dissipate, and the cosmos will settle into a long darkness. *Obeat lux.*

In their paper Georgi and Glashow, afraid of the reaction that this implication would provoke, refrained from mentioning it until the end: "Finally, we come to a discussion of superweak interactions and . . . superheavy vector bosons. In addition to mediating [some] bizarre interactions . . . they make the proton unstable."

"Unity of All Elementary-Particle Forces" appeared in February of 1974, and initially met with little favor. Most theorists didn't even notice it in the flood of models that had been provoked by 't Hooft's proofs. Some of those who did pointed out that the $SU(5)$ paper failed to provide any clear reason for supposing that the coupling constants could be made equal. But a reason was provided a few months later, in a paper that Georgi wrote with Weinberg and Helen Quinn, who, like Georgi, was a postdoctoral fellow at Harvard.

"Hierarchy of Interactions in Unified Gauge Theories" was published in *Physical Review Letters* in August of 1974. In it the authors pointed out that the coupling constants of electromagnetism and the weak force are not true constants at all, but vary with the energy of the interactions. In fact, as the energy of the interactions increases, the values of the "constants" change. At 10^{14} GeV and higher, the coupling constants converge. More important, at these high energies the coupling constant of the strong force dips down, and ultimately it joins that of the other two. Where the coupling constants merge, the three forces reveal their unity. (Hopes for a complete unification rest on the belief that the gravitational coupling constant must behave in a similar way.)

Now, 10^{14} GeV is a lot of energy for one particle to have. It corresponds to a temperature of about 10^{28} degrees Fahrenheit—one so extreme that it has not been reached in the universe since the first fraction of an instant after the Big Bang. Thus, whereas Georgi and Glashow had shown that uniting the strong, weak, and electromagnetic forces is theoretically possible, Georgi, Quinn, and Weinberg showed that these forces had actually been united only at the beginning of time, after which they had separated like curds and whey. When Georgi, Quinn, and Weinberg plugged the conjoined coupling constant into $SU(5)$, moreover, they found that the average lifespan of protons is roughly 10^{31} —ten quadrillion quadrillion—years.

S $U(5)$ COVERS BOTH THE BEGINNING AND THE END OF existence. And the model provides clues for hooking gravity into it as well, for total unification. Since the confirmation of charm and weak neutral currents, theorists have been scrambling to decipher these clues, and they have produced various hypotheses known as "supersymmetry," "supergravity," and "quantum gravity." All use Georgi and Glashow's GUT as a starting point, in the same way that $SU(5)$ uses $SU(3) \times SU(2) \times U(1)$.

The result is a ladder of theories. Firmly on the bottom is $SU(3) \times SU(2) \times U(1)$, whose predictions have been confirmed ("to the point of boredom," Georgi says) by Ting, Richter, and others. The W and Z particles were discovered at CERN, an international physics laboratory in Geneva, Switzerland, last year, but the theory was so well established by then that the event was—for theorists, at least—an anticlimax. The GUTs proposed by Georgi and Glashow and other physicists, which fully unite the strong, weak, and electromagnetic forces, are the next rung on the ladder. Although as yet unconfirmed, these theories are considered compelling by most physicists. Finally, at the top of the ladder, in the theoretical stratosphere, are supersymmetry and its cousins, which are organized according to a principle somewhat different from $SU(5)$, though, like that model, they put apparently different particles together in groups. Supersymmetry groups are large enough to include gravity, but are so speculative that many experimenters doubt that they can ever be tested.

"Do you remember Antaeus, from Greek mythology?" Maurice Goldhaber, a physicist at Brookhaven, asks. The brother of Gerson Goldhaber, whose discovery clinched the case for charm, Maurice is skeptical of the current trend toward very speculative theories. "Antaeus was the strongest person alive, invincible as long as he was in contact with his mother, the earth. Once he lost contact with the earth, he grew weak and was vanquished. Theories in physics are like that. They have to touch ground for their strength."

Nevertheless, it is easy to see why physicists are attracted to such speculation. The emerging view of the universe is compellingly simple. Although the models differ, the broad thrust of each is the same, and all promise to describe not only the relationships among the types of forces and matter in the cosmos but also the history of the cosmos.

On the far side of the Big Bang is a mystery so profound that physicists lack the words even to think about it. Those who are willing to go out on a limb guess that whatever might have been before the Big Bang was, like a vacuum, unstable. Just as there is a tiny chance that virtual particles will pop into existence in the midst of subatomic space, so there seems to have been a tiny chance that the nothingness would suddenly be convulsed by the presence of a something.

This something was an inconceivably small, inconceivably violent explosion, hotter than the hottest supernova and smaller than the smallest quark, which contained the stuff of everything we see around us. The universe consisted of only one type of particle—maybe only one particle—that interacted with itself in that tiny, terrifying space. Detonating outward, it may have doubled in size every 10^{-35} (one divided by 10^{35}) seconds or so, taking but an instant to reach literally cosmic proportions.

Almost no time passed between the birth of the universe and the birth of gravity. By 10^{-43} seconds after the beginning the plenum was already cooler, though hardly

hospitable: every bit of matter was crushed with brutal force into every other bit, within a space smaller than an atomic nucleus. But the cosmos was cool enough, nonetheless, to allow the symmetry to break, and to let gravity crystallize out of the unity the way snowflakes suddenly drop out of clouds. Gravity is thought to have its own virtual particle (the graviton), and so the heavens now had two types of particles (carriers of forces and carriers of mass), although the distinction wasn't yet as clear as it is in the universe today.

At 10^{-35} seconds the strong force, too, fell out of the grand unified force. Less time had passed since the Big Bang than it now takes for a photon to zip past a proton, and yet the cosmos was beginning to split. Somewhere here, too, the single type of mass-carrying particle became two—leptons and quarks—as another symmetry broke, never to be complete again. The universe was the size of a bowling ball, and 10^{60} times denser than the densest atomic nucleus, but it was getting colder and thinner rapidly.

One ten-billionth of a second after the Big Bang the firmament reached the Weinberg–Salam–Glashow transition point, and the tardy weak and electromagnetic forces broke away. All four interactions were now present, as well as the three known families of quarks and leptons. The basic components of the world we know had been formed.

"Let me draw the whole picture for you," Glashow says, putting a line in white chalk from one end of the blackboard to the other. "This represents the universe from the beginning to the end of time." After thinking a moment, he draws a second line in purple chalk; it is just a bit shorter. "We live in the fortunate era—the era in which there is matter. Matter first appeared 10^{-38} seconds or so after the Big Bang, and will all disappear maybe 10^{40} seconds from now." He hunts around in the tray below the board, finally happening upon a piece of brown chalk, which he uses to plot a line considerably shorter than the first two. "Within the fortunate era of matter there is a somewhat shorter period in which atomic nuclei exist, because the universe is cool enough to permit them to form. And within that—a red line now, barely a foot long—an even tinier domain in which there are atoms." He makes a dot near one end of the red line. "Then you have a brief ten billion years or so when things are palatable on Earth."

"After that, eventually it all winds down. We won't be bothered when, say, ten percent of the protons go. If we're still around, we may not even notice. But when ninety-nine percent go, you won't have enough left to make a person, and it will be unpleasant. After this point there's a long period of decline, and a very boring period it is, too. This is not a view we could have gotten without Grand Unified Theories. We may not like it, but we have no choice."

Some physicists, in fact, do not like it, nor do they like the general effort that has brought so many in their field around to Glashow's view. Glashow's former teacher Julian Schwinger is one. He says, "Unification is the ultimate goal of science, it's true. But that it should be unification

now—surely that's the original definition of hubris. There are a heck of a lot of energies we haven't gotten to yet. Grand unified schemes make the implicit assumption that what happens in them is not fundamentally different from what we know—an assumption about how nature works that's in conflict with what we've spent the last century learning."

WHETHER GLASHOW OR SCHWINGER IS CORRECT IS A matter for experimenters to determine. The Grand Unified Theories make two further predictions, one of which is proton decay—an idea that Glashow phrases as the question "Are diamonds forever?"

Maurice Goldhaber has been charting the lifetime of the proton for some thirty years. He says, "They used to say the proton was immortal. But I asked myself, how do they know the proton has a guardian angel watching over it? This is not a question for theorists. It's really a question for experimenters. You cannot just tell your children that the proton is stable. You have to go find out. There are two ways to do it. You can watch one proton for quadrillions of years to see if it decays, or you can watch quadrillions of protons for one year to see if any of them decay." The more protons that remain stable as you watch, the longer it must take for the last proton to disappear. In 1953 and 1954 Goldhaber began to gather a lot of protons in one place to see if they would decay. Eventually he and other experimenters succeeded in proving that, on the whole, protons are good for at least 10^{27} years—the lifetime that Georgi and Glashow found in a book in Lyman Hall.

Today Goldhaber is at work on a proton-decay experiment with scientists from the University of California at Irvine, the University of Michigan, and Brookhaven. Located in a salt mine half a mile deep by the shore of Lake Erie, the experiment consists, as Glashow puts it, of "a big swimming pool lined with plastic garbage bags." The swimming pool is filled with 8,000 tons of water so pure that it would dissolve the oil out of your skin if you stuck your hand in it. (Eight thousand tons of water hold about 10^{34} protons.) It took two years to dig the hole, which measures seventy feet on each side, seal it with polyethylene, and line it with more than 2,000 photodetectors. On the day the experiment began, Goldhaber toasted the collaboration with the words "To the proton—may it live forever! But if it has to die, let it die in our arms!"

For almost two years, experimenters have been watching the tank. So far they have found no sure sign of proton decay; the minimum lifespan is now 10^{32} years and climbing. Other, smaller tests have turned up what might prove to be evidence of proton decay, but, as Goldhaber says, "Not every candidate is elected."

Glashow is unperturbed. "I'm convinced the theory is sound. We can fiddle some more with the proton lifetime, if the thing comes to that. But the essential framework of the GUTs simply explains too many things for it to be fundamentally wrong. We have the outlines of a full theory,

and a few experimental results aren't going to change that. Besides, it's a mistake for theorists to take too seriously the first batch of experimental results."

Although Glashow is sanguine about the ultimate result of the proton-decay experiments, he is much less happy about the second prediction implicit in the Grand Unified Theories—namely, that proton decay is the *only* major new phenomenon that experimenters will find. According to SU(5), all the important aspects of the strong, weak, and electromagnetic interactions are understood, and thus the immense range of energy that lies between the 1,000 GeV that accelerators today can provide and the 10^{14} GeV needed to confirm the GUTs should contain no surprises. That vacant expanse—in which the sole landmark is proton decay—has come to be known as "Glashow's desert." Proud though Glashow is of the giant step toward unification that SU(5) represents, he and most of his colleagues believe that the desert does not exist, and that therefore the model is wrong—or wrong in part, anyway. SU(5) is successful as a prototype, in other words, but it will probably be replaced by another model.

Already experimental evidence may have put a dent in SU(5). Late last March two groups of researchers at CERN stunned the physics world when they announced that the same experiments that had turned up the W and Z particles had also happened upon bizarre subatomic events that apparently are not predictable by either SU(5) or the standard model. In mid-May, Carlo Rubbia, a physicist at Harvard who leads one of the teams at CERN, gave a talk at a centennial celebration of the Harvard physics laboratory in which he described still other anomalies so peculiar that some physicists immediately dubbed them "Zen events." These discoveries have yet to be confirmed, because the heavy demands on CERN's accelerator will not allow Rubbia to use it again until the end of September.

Although physicists don't yet know what the new findings mean, these seem to be associated with the Z^0 . When Rubbia and his colleagues examined the subatomic collisions that produce Z^0 s, they found that these particles decay by shooting out photons in a way that the standard model does not seem to explain. When the teams at CERN looked closely at the data, they also discovered unexpected sprays of subatomic particles ("jets," in the jargon). These may indicate that the Z^0 s are created by the decay of heavy particles that, according to Georgi, "are not on any current map."

There was another interesting result. When protons and anti-protons collided at the unusually high energies Rubbia was employing, the subatomic debris created should have flown out in several directions, but instead, in a few instances, it flew out in only one. It is specifically this behavior that physicists have in mind when they jokingly refer to "Zen events," because it is suggestive of the Buddhist conundrum about the sound of one hand clapping. "A large amount of energy seems to disappear," Rubbia says. His sharp and obvious pleasure in being on the trail of something unknown is evident in his voice. "It is com-

pletely unaccounted for! Its disappearance could be the sign of a neutral, weakly interacting particle of a kind we've never seen."

Rubbia continues, "We don't know if we're seeing one phenomenon or aspects of several different phenomena. I can only tell you this: the probability that it is an error or background—or, better, that it is irrelevant—is, according to the standard laws of physics, extremely small. I could be wrong. In this kind of stuff, there is always room for error. But we have a clean, strong signal, not one of these muddy is-it-or-isn't-it messes. You can *see* the damn things."

The news from CERN has invigorated theorists. Before the findings were even published, physicists were discussing Rubbia's surprises at congresses and seminars, gossiping about them in corridors, and scribbling speculations based on them on napkins in laboratory cafeterias. Theorists are riveted by the possibility that the results at CERN are a signpost pointing the way at least to a confirmed Grand Unified Theory, if not, someday, unification itself.

Although Gerald Feinberg is excited by the results, he cautions, "It's still too early to say. These events could *look* like things that are not in the standard model but really be compatible with it, because nobody has explored the implications of the standard model thoroughly enough. People are still learning about it." Georgi, too, thinks the findings are unlikely to challenge the basic validity of $SU(3) \times SU(2) \times U(1)$, but hopes they will ultimately help physicists go beyond this theory.

Glashow, for his part, is delighted by the anomalies. "Physics has gotten interesting again," he says cheerfully. "I appear to have been proven decisively wrong about the desert, thank God. I don't think it will happen, but there's the exciting possibility that thirty years of work will go down the tube, and that everything we know is totally wrong. I myself have written two papers alleging to explain why strange things should happen with Z^0 s. I submitted one of them just yesterday to *Physics Letters*. It should be out in August sometime. In it I claim that what

we're seeing is the first manifestation of a fifth force of nature—the 'smelly force.' It has to do with a previously unknown property I call 'odor.' Odor goes along with color, right? I note that the $O(18)$ group, which I'm pushing, predicts that there could be *hundreds* of odoriferous particles—or maybe I said 'odorous.' Anyway, I'm really talking *structure*."

He chuckles as he anticipates the reaction of his colleagues to this idea. (Rubbia, in fact, upon being told that he might be the discoverer of the smelly force, guffawed and said, "Shelly's got a million ideas, doesn't he?" Rubbia paused for a moment, and then said, "On the other hand, come to think of it, there might be something to it.")

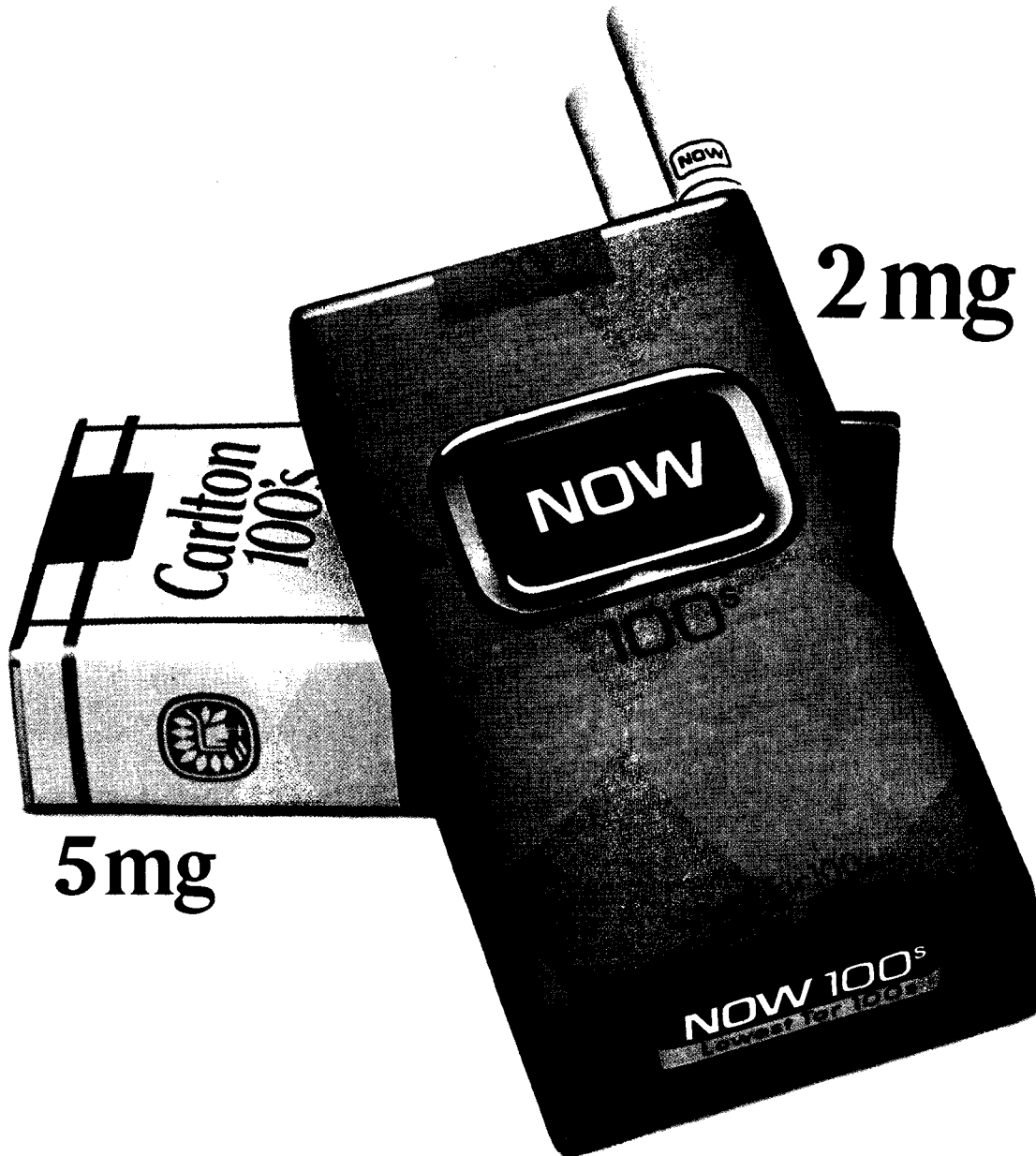
"Listen to this," Glashow says, grabbing the manuscript of his odor paper. "It's highly technical, most of it, but here's the good part. I say, 'An example of a Grand Unified Theory producing effects such as we describe is $O(18)$ with [all particles that are not bosons] belonging to a single 256-dimensional representation. At low energy, the effective field theory can be based on the subgroup $O(5) \times SU(3) \times SU(2) \times U(1)$, with $O(5)$ and $SU(3)$ unbroken and $SU(2) \times U(1)$ spontaneously broken to electrodynamic $U(1)$. This is not, of course, the whole story. . . . The $O(18)$ model also involves twenty-six colorless but odorous leptons.' "

He breaks off. "I was thinking about ending it with the words 'No desert here,' but I decided the editors would argue too much about it. Anyway, there's a lot of other good ideas people have been tossing around. Howard Georgi and I are working on another paper that I think is *really* interesting. You see, if you look at the configuration of these events, it's clear that. . . ."

For another half hour Glashow, like the Walrus and the Carpenter, talks of many things—of the seventh quark and the fourth neutrino; of sliding constants and expanding groups; of the symmetries of odor and how to spot the Higgs boson; of color, flavor, and mass; and of many other signs and wonders that nature has in store for those who walk the road to unification. □



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MUSIC

THE LOSS OF COUNT BASIE

BY FRANCIS DAVIS

FORECASTING THE PATHS that big-band jazz might travel is difficult now that another of its pacesetters has reached the end of his journey. In symbolic terms, the loss of Count Basie, who died last April, a few months shy of his eightieth birthday and a year away from his golden anniversary as a bandleader, is incalculable. Among big-band leaders only Duke Ellington exerted more long-term influence upon jazz and American popular music. Indeed, Ellington and Basie are often cited in the same breath as exemplifying everything rich and grand and irretrievable in the jazz past—the Duke and the Count, the last of a bygone aristocracy.

Yet Ellington and Basie represented contrasting approaches to the jazz orchestra. For Ellington, the big band was a blank page, upon which he wrote the most enduring body of orchestral literature in jazz history. Basie functioned more as an editor, although his signature was just as plain. Even in the 1930s, when the Basie Orchestra was enjoying its first national triumph with its largely unnotated arrangements (the bulk of them credited to Basie), the leader's piano was less pad and pencil than general-assignment desk, according to the testimony of his sidemen. "Basie would start out and vamp a little, set a tempo, and say 'that's it!'" the trombonist Dicky Wells remarked in his 1971 autobiography, *Night People*.

He'd set a rhythm for the saxes first, and [the alto saxophonist] Earle Warren would pick that up and lead the saxes. Then he'd set one for the bones and we'd pick that up. Now it's our rhythm against theirs. The third rhythm would be for the trumpets, and they'd start fanning with their derbies. . . . That's how Basie put his tunes together. He had a big band, but he handled it as though it were six pieces.

According to the outside arrangers

Francis Davis writes about music for the Philadelphia Inquirer, the Boston Phoenix, and a variety of national publications.

whom Basie employed with increasing regularity beginning in the mid-fifties, band rehearsals generally found Basie penciling out everything in their scores he recognized as superfluous to the real matter at hand—that ineffable sensation jazz partisans call *swing*, practically a Basie patent. Although he gave the impression of being a laissez-faire leader—delegating musical authority to deputies, including the alto saxophonist Marshal Royal and the rhythm guitarist Freddie



Green—Basie apparently demanded of his sidemen a commitment to basics as single-minded as his own. He seems to have had little tolerance for errant behavior off the bandstand; to judge from what his intimates say, he had no vices or affectations, save for the captain's hat he wore in later years. ("Count Basie! Where'd you park the ship, Count?" an old Kansas City crony asks him in the film *The Last of the Blue Devils*.)

To say that big bands were essentially the domain of composers and arrangers until the arrival of the Count Basie Orchestra in New York in 1936 would be an

exaggeration, for there were charismatic improvisers in such "composer's" bands as Ellington's, Fletcher Henderson's, and even Paul Whiteman's. Still, it is fair to say that Basie deflated some of the pomposity that had attached itself to the big-band idiom, by encouraging his men to blow the blues as freely in performance as they might during informal gatherings. Basie deployed the full complement of horns not so much to frame his soloists as to goad them on with escalating call-and-response background riffs that ricocheted from section to section on the greased wheels of a locomotive rhythm section that included Basie, Freddie Green, the bassist Walter Page, and the drummer Jo Jones. A spirit of big-band camaraderie infused the unrefined ensemble passages, and jam-session rivalry fueled the solos, with three pairs of evenly matched opponents (the trumpeters Buck Clayton and Harry Edison, the trombonists Dicky Wells and Benny Morton, and the tenor saxophonists Lester Young and Herschel Evans) locking horns. As if all this weren't excitement enough, Jimmy Rushing stood out front hollering the blues as if trying to shout down the entire aggregation.

This loosening of musical inhibitions was not something the Basie Orchestra, or any other band, accomplished by itself. Nor was it Basie's major contribution to jazz. Amid his band's explosions there were subtleties and divinations. For quite some time jazz rhythm sections had been moving away from a rigidly syncopated two beats to the measure toward a more rippling and evenly accentuated four-four, but it took the rhythm team of Jo Jones and Walter Page to map the route clearly for all to follow. Lester Young presaged bop, cool, and even free jazz with his reed-thin vibrato (a contrast to the beefier tone of his section mate Evans), his musings on chord substitutions and passing tones, his peering around bar divisions, and his games of cat-and-mouse with the beat.

This great band remains the standard against which all other big bands have to be measured (Duke Ellington's being *sui generis*), and it is small wonder that most come up wanting. The retooled Basie band of the 1950s was a precision instrument nicknamed "The Basie Machine" by its admirers—a phrase that caught on with the band's detractors as well. Despite the presence of a number of competent soloists, including the cornetist Thad Jones and the saxophonists Frank Foster and Frank Wess, the stars

of this band were the arrangers (including Foster, Neal Hefti, Ernie Wilkins, Buster Harding, and Wild Bill Davis) who codified the informal Basie style into a tight, instantly recognizable sound. Yet if this band was noticeably less freewheeling than the original model, it was no less potent, and judged as an ensemble rather than as a donnybrook among rugged individualists, it may even have been the superior unit. One must turn to Ellington to hear a consummation of brass and reeds as blithe and incandescent as the Basie Orchestra's recordings of Foster's "Shiny Stockings," Hefti's "Cute," and Davis's hit arrangement of "April in Paris" (a guilty pleasure, this last item—exhilarating despite its pop-goes-the-weasel quotes, fake endings, and Basie's coy exhortations of "One more time!"). The Basie Orchestra of the fifties was a machine whose motor purred; and hindsight reveals that Basie was right in gear with the larger movements of the period. The emergence of hard-bop groups, like the Jazz Messengers and the Horace Silver Quintet, signaled that jazz was returning to basics after a decade of creeping intellectualism—and Basie, though his music bore scant resemblance to the hard-bop phenomenon, was a man who had sworn by basics all along.

BASIE LEAVES AN impressive legacy. A number of collections bear the title *The Best of Count Basie*, but only one fully warrants the superlative: the two-record set of the Basie Orchestra's landmark Decca recordings from the late thirties, which includes the original versions of "One O'Clock Jump," "Jumpin' at the Woodside," "Swinging the Blues," "Every Tub," "John's Idea," and "Doggin' Around" (MCA 2-4050). Perhaps the best thing about this *Best of* is that it whets the appetite for more vintage Basie. A good place to start is with the Bennie Moten Orchestra, the outfit that served as incubator for the Basie Orchestra in Kansas City in the mid-thirties. Regrettably, there is not a single domestic collection of Basie's work with Moten now available, but French RCA Victor has released three double albums devoted to that seminal band; Basie figures prominently in two of them, *The Complete Bennie Moten, Volumes 3/4* (PM 43693) and *Volumes 5/6* (PM 45688). Both *Good Morning Blues* (MCA 2-4108) and *Super Chief* (Columbia 31224) are delightful two-record potpourris of Basie's music from the thirties, the latter espe-

cially valuable because it includes four numbers with just Rushing, Young, the trumpeter Carl Smith, and the Basie rhythm section. (*Super Chief* only scratches the surface. The rest of the influential 1936–1939 Basie small-group sessions were last available spread out over the five double-album sets of Columbia's *The Lester Young Story*, which are now out of print—though all five still turn up in remainder bins from time to time.)

The 1940s were a decade of transition for jazz, and some of the changes were reflected in the styles of the parade of tenor saxophonists who marched with the Basie band following the death of Evans and the defection of Young: Don Byas, Paul Gonsalves, Illinois Jacquet, Lucky Thompson, Wardell Gray, and Charlie Rouse. The best compendium of forties Basie is the two-record import *The Indispensable Count Basie* (French RCA Victor PM 43688), although both *Blues by Basie* (Columbia PC 36824) and *One O'Clock Jump* (Columbia Special Products JCL 997) have plenty to recommend them, not the least of which is that they are comparatively easy to come by.

Basie's output during the fifties and the early sixties was staggering, and most of his best albums from that period remain in print, including *April in Paris* (Verve 2641), *Basie* (popularly known as *The Atomic Basie*; Roulette 59025), *Basie Plays Hefti* (Emus 12003), and the two-record sets *16 Men Swinging* and *Paradise Squat* (Verve 2517 and 2542).

The seventies and eighties witnessed no decline in the quality or quantity of Basie's work. The last decade of his life was the most productive of his career, at least in terms of his own coming out as a pianist. When there is a roll call of the great soloists from the Basie Orchestra of the thirties, the leader's name is usually conspicuous by its absence. Long a reticent soloist, Basie finally began claiming the spotlight for himself, after several nudges in the right direction from his record producer Norman Granz. In addition to documenting the still vital Basie Orchestra on such fine Pablo releases as *Farmer's Market Barbecue* (2310 874), *Me and You* (2310 891), and the recent *88 Basie Street* (2310 901), Granz inaugurated a series of small-group sessions that pitted Basie against veteran improvisers of equal caliber. There were memorable confrontations with the trumpeter Dizzy Gillespie (*The Gifted Ones*, 2310 833), the tenor saxophonist Zoot Sims (*Basie and Zoot*, 2310 745), and the blues singers

Joe Turner and Eddie "Cleanhead" Vinson (*Kansas City Shout*, 2310 859), as well as several brushes with fellow pianist Oscar Peterson (including *Satch and Josh*, 2310 722), and carefree trio dates with the bassist Ray Brown and the drummer Louis Bellson (*For the First Time*, 2310 712, and *For the Second Time*, 2310 878). All these records point to Basie's sustained vigor, his telling economy, and his sneaky wit, and they send the listener back to thirties Basie for his bare-bones solos and ad-lib intros. It was always possible to hear echoes of Fats Waller and the grandiose Harlem stride men in even the leanest of Basie's improvisations, but it also becomes possible, in retrospect, to hear premonitions of such modernists as John Lewis and Thelonious Monk in Basie's pregnant silences, the illusory bend of his blue notes, and the dot-dot-dash inevitability of his figurations. At last the cat is out of the bag: Count Basie was one of the masters of jazz piano.

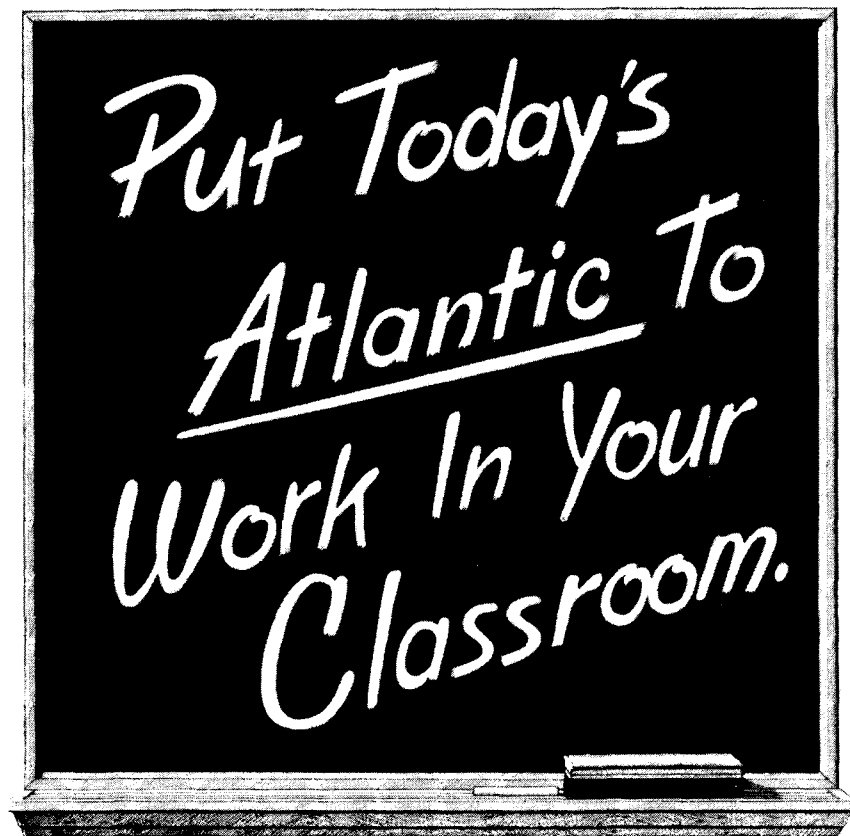
BASIE'S FELICITIES AS a pianist notwithstanding, his name will always be synonymous with big bands. Over the past three decades the Basie Orchestra suffered bouts of inertia, as any institution sometimes does, but it seemed to be on the move again in recent years. A week after Basie's death the Willard Alexander agency confirmed that the Basie Orchestra would indeed soldier on without its leader. A refusal to let go of the past reduces history to nostalgia; aesthetically, ghost bands are sweet cheats, no matter how pristine their intentions. Taking over the reins of the Duke Ellington Orchestra after his father's death, ten years ago, Mercer Ellington promised to blow the cobwebs off some of the masterpieces from the twenties and thirties that Duke had long ignored. But many of the veteran Ellingtonians who had conspired to give the latter-day Ellington Orchestra its distinctive voice had died or were to die within a few years of their leader, and many others had retired. Mercer soon found himself conducting an Ellington Orchestra in name only for audiences eager to hear a nostalgic medley of Ellington's hits rather than obscure but historically central Ellington compositions. (Thus the languors of the Broadway revue *Sophisticated Ladies*.) Even assuming there can be a Count Basie Orchestra without Count Basie, can there be a Basie Orchestra without his longtime sidekick Freddie Green, himself reduced

to part-time status by the infirmities of age?

Only a few musicians from the golden era of big bands are still out there on the road. Lionel Hampton continues to put on a terrific show, and the indefatigable Woody Herman is as vital and amenable to change as ever, even if his band is no longer a spawning ground for great stylists. Buddy Rich fronts a big band whenever he is physically and economically able to, and Artie Shaw—ever the iconoclast—has sent a ghost band on the road, though he's still very much alive. Benny Goodman's poor health makes recurring rumors that he will again enter the fray seem like wishful thinking.

Big bands are an endangered species, if by *big band* one means a style of presentation associated with the popular music of the thirties and forties. But within jazz *big band* also reveals sheer love of size, and big bands in that sense are still plentiful—college lab bands; television talk-show orchestras; busman's-holiday "rehearsal" bands like those that begat the Thad Jones–Mel Lewis Jazz Orchestra in New York in the mid-sixties and the Toshiko Akiyoshi–Lew Tabackin Big Band in Los Angeles a decade later; expanded units of fluctuating sizes and instrumentations led by pantonalists like Sun Ra, George Russell, and Muhal Richard Abrams, protean composers for whom the orchestra promises wider compositional latitude, much as it must have for Ellington.

Still, the downscale economics of jazz ensure that most rehearsal bands will remain just that, performing before live audiences only rarely. Orchestras like Russell's and Abrams's tend to exist only in the recording studios, save for appearances at European festivals and an occasional week at a New York club. It hardly seems likely that big bands of any kind will ever again enjoy the widespread popularity that the big swing bands enjoyed in the years leading up to the Second World War, when jazz and popular dance music were virtually one and the same. Nothing in jazz is quite as thrilling in quite as many ways as a roaring big band. But the melancholy fact of the matter is that since jazz has evolved into an art music of limited popular appeal, contemporary jazz musicians will have to forgo the luxury of thinking big, except on rare occasions. The loss of Count Basie hits harder for underscoring everything else jazz has lost and figures to go on losing. □



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FOOD

SUMMER ICES

BY CORBY KUMMER

I HAD TO STOP everything when I took my first bite of *gelato*, the Italian version of ice cream. Although I was in front of the Palazzo Vecchio, in Florence, and surrounded by some of the most famous sculptures in the world, I could concentrate only on what tasted like the biggest, ripest, most richly flavored peach imaginable. It made the ice creams I had had before seem chalky. Each flavor I went back to try—apricot, blueberry, fig, melon—also seemed like the apotheosis of the fruit. The lemon and grapefruit were almost overwhelming in intensity. Why didn't I know about this? I wondered. Why hadn't anyone opened a *gelateria* in America? I decided that I had found my way to get rich quick.

Naturally, I waited too long. The ice-cream craze that has made Häagen-Dazs and other rich ice creams so popular is being joined by a *gelato* craze. *Gelato* as a rule has half the butterfat of ice cream but is more powerfully flavored. The first in the new wave of American *gelaterie*, a store called Gelato, opened in

San Francisco in 1976 and now has twenty-one branches. *Gelaterie* are common all over California, and new ones have opened recently in New York, Boston, and Chicago, and in Texas, Arizona, Michigan, Colorado, and Florida, among other states. Several brands of *gelato* are being distributed to supermarkets. But almost no one is making the kind of fruit *gelati* I dreamed of tasting again. I recently found out why.

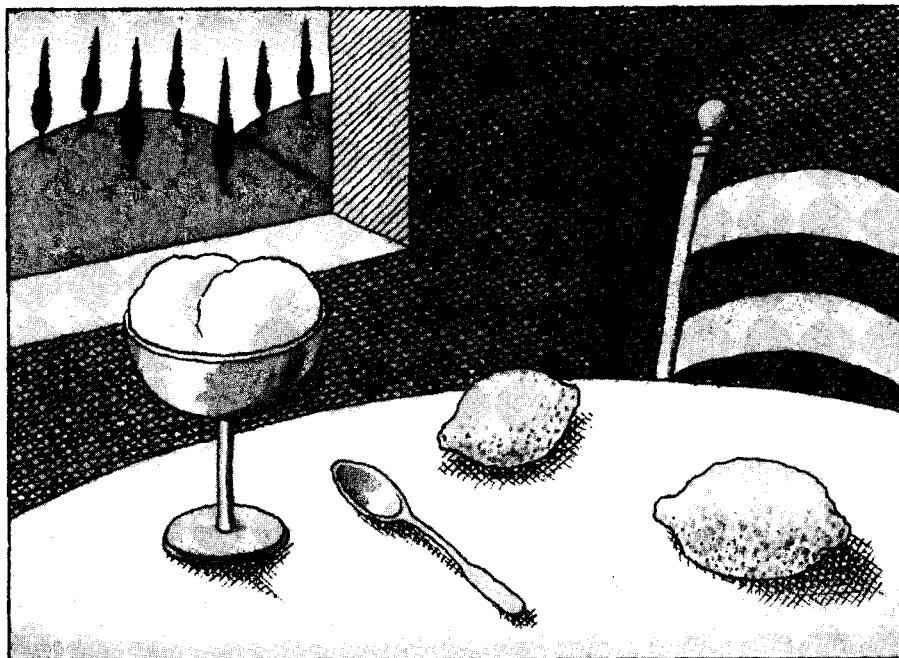
Although anything sold in a *gelateria* is called *gelato*, the term covers two ice creams and two water ices. The most popular is *gelato* itself, made with egg yolks and milk or cream. (American ice cream sometimes uses egg yolks and generally uses cream.) Flavors are typically chocolate; *gianduia*, or chocolate with hazelnut; and *crema*, which corresponds most closely to vanilla. *Semifreddi* have a lighter texture and are made classically of whipped cream but often with pastry cream or meringue added, in flavors such as *zabaione* (egg yolks and marsala) and chocolate chip. *Sorbetti*—the fruit ices I fell in love with—are made with roughly equal proportions of pureed fruit, usually uncooked, and a syrup of sugar and water, usually cooked, as

the syrup in a French sorbet is. (The translation should be “sherbet,” but in America sherbets are high in sugar, low in fruit, and use milk.) *Granite* have the texture of chipped ice. They resemble Sno-Kones, except that the chips of ice are bigger and the flavors, usually lemon and coffee, are not artificial.

The way to make a really good fruit ice is to use a lot of fresh fruit. Almost no one does this. Instead, manufacturers add a lot of sugar, which enhances the flavor of the small amount of fruit they use. Many commercial *sorbetti* use gums as a stabilizer, to prevent too many ice crystals from forming—the function of the cream in ice cream, the egg yolk in *gelato*, and the sugar in *sorbetti*. Manufacturers can't avoid using gums: a pure mixture of fresh fruit, water, and a small amount of sugar won't keep its flavor and texture longer than a day. Most of the new *gelato* stores in America use imported bottled bases made up of syrup, some pureed fruit, and gums. Even Vivoli, the most famous *gelateria* in Florence, admits to using some of these bases.

It's no wonder that the number of *sorbetti* available either in *gelaterie* or in supermarkets is very small, and that most rely principally on sugar and on stabilizers for flavor and texture. Buying, peeling, and chopping the quantities of fresh fruit required to produce a good *sorbetto* is expensive and time-consuming. Each fruit needs to be frozen in a different way, depending on its sugar and water content. For instance, strawberries are high in water, bananas low. The fiber and enzymes in papayas make them difficult to freeze. Other fruits, such as cantaloupe and honeydew, are so delicate that their flavors can disappear once a syrup is added. American apricots are usually so tasteless that it is better to use dried ones, which requires other recipe adjustments. Most restaurants and manufacturers can't be bothered with mastering the fine points of such a temperamental product—especially one that should properly be thrown out if it's not eaten the day it is made.

THE BEST WAY to have a delicious fruit ice, then, is to make your own. You don't need a special machine, and the effort required makes more sense than that for homemade ice cream: you can buy good ice cream. Perhaps the chief problem in trying to duplicate Italian *sorbetti* is that Italian fruit has much more flavor than American fruit and is



Corby Kummer is an associate editor of The Atlantic.

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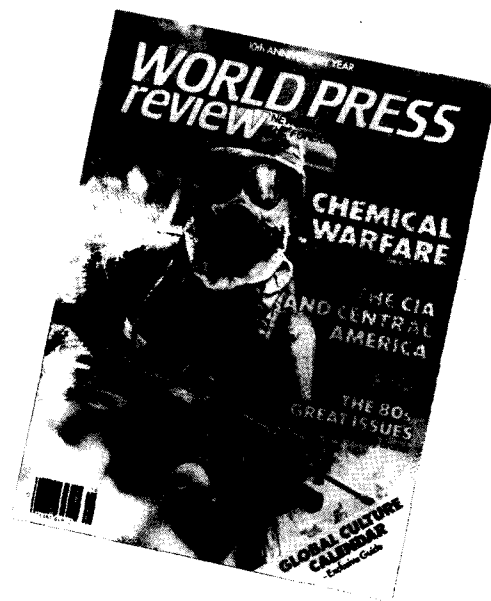
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LITTLE, BROWN

Also available from The Atlantic Bookstore, page 113.

riper when picked. It is safest to choose ripe fruit that is in season. Although some fruits, like apples and cranberries, need cooking, most cooked fruits will make the *sorbetto* taste like jam. You can make up for lack of flavor by adding a tablespoon or so of liquor to a quart of liquid—rum and banana, cassis and lemon, and Poire William and pear are classic combinations.

A homemade *sorbetto* uses a sugar syrup, which is one part sugar and one part water boiled together for five minutes and then cooled. Two parts fruit puree or juice are added to the syrup, and the mixture is frozen. You can freeze the mixture in an ice-cream maker, which continuously beats air into it as it freezes, but you're almost as well off putting it into an ice tray with the dividers removed or into a cake pan, and transferring it to a chilled bowl to beat it twice—after it turns to slush and before it freezes completely. The whole freezing process takes between three and five hours. After the *sorbetto* is frozen hard, you should put it in the refrigerator for an hour or so to temper it before serving.

Although the sugar produces a pleasing consistency and prevents a *sorbetto* from freezing to a solid block of ice, it has a distinctive taste that often masks the taste of the fruit. Using half syrup and half fruit, as a *sorbetto* requires, can make for a dessert that is too sweet for many people's taste, even if you add the juice of one or two lemons to point up the flavor of the fruit and cut the sweetness—a good trick. Fructose, powdered fruit sugar, is one and a half times as strong as white sugar and does not have a taste of its own. You can make a cooked syrup with fructose or add enough to the fruit puree to sweeten it. Any *sorbetto* mixture should taste too sweet and too strong before you freeze it, since freezing diminishes flavor.

If you stir in fructose to your liking rather than make a cooked syrup, the result will be a cross between a *granita* and a *sorbetto*. You must add a stabilizer in order to avoid chunky ice crystals and achieve the desired consistency of densely packed snow. A small amount of gelatin is one choice: two teaspoons, dissolved in a quarter cup of hot water and then cooled, is enough for a quart of liquid. Many people dislike the taste of even so little, however. Another possible stabilizer is one or two beaten egg whites, although some people say that they make a *sorbetto* taste like a frozen

meringue. But either gelatin or egg white is required for making low-sugar fruit ices at home. You should beat the mixture twice too. If you don't have an electric mixer, use a whisk. You can also use a food processor, which will break down the ice crystals although it will not incorporate air into the *sorbetto*.

Although it is best to arrive at your own final recipe for each kind of fruit ice, there are good basic recipes for sorbets in many cookbooks—for example, *The Joy of Cooking* and Volume II of *Mastering the Art of French Cooking*. The best of the recipe books I have tried is *The Book of Ices*, which was written in London in 1885 by Mrs. A. B. Marshall, a cooking teacher and entrepreneur, and has been annotated for modern readers by Barbara Ketcham Wheaton. It has recipes for a good variety of water ices with fruit and for ices based on custard or plain cream. The Metropolitan Museum of Art, in New York, has recently re-issued the small book in an edition charmingly illustrated with period photographs and engravings and retitled *Victorian Ices & Ice Cream*. Giuliano Bugialli claims in his *Classic Techniques of Italian Cooking* that the best Italian fruit ices actually begin with the same custard base used in *gelati*, and he gives a recipe for fruit *gelati*. It requires an ice-cream machine, and has all the cholesterol that *sorbetto* lovers are proud of avoiding.

The quality of the *sorbetto* I've tasted at some of the new *gelaterie* in New York and the Boston area has been depressingly low. I have found a few exceptions, stores whose owners are intent on using only fresh ingredients. Giuseppe Dietrich, an Italian, makes *sorbetto* at his Gelateria Giuseppe, at Harvard Square, in Cambridge, that have the right creamy consistency. Kenneth Horn, a twenty-seven-year-old lawyer who went to Italy to learn to make *gelati*, makes the real thing at his Gran Gelato, in New York City. The two chefs who own New York Ice, in Greenwich Village—Shipen Lebzelter and Guido Magnaguagno—make subtle fruit *granite* sweetened with fructose. The flavors are clear and powerful, and the chefs are inventive: grapefruit and Campari, for instance, is especially good. Gelateria Giuseppe might offer franchises, and New York Ice is expanding its distribution. But in the meantime, try making your own before fall, while you can find the greatest variety of fresh fruits. The best fruit ice you ever taste might be your own invention. □

SPORTS

BOXER WITH A FUTURE

BY G. A. TAUBES

BEFORE MARK BRELAND fought and beat Serik Konakbaev for the world's amateur welterweight championship, in May of 1982, in Munich, he assured the press that the Soviet boxer would not, as Breland put it, get in his way. He also pointed out that Konakbaev, a silver medalist in the 1980 Olympics and the winner of more than 140 amateur fights, occasionally dropped his guard after throwing lefts. Although bravado seems to be standard equipment for fighters, Breland's remarks were both softly spoken and to the point, a simple statement of his determination and foresight.

Consider what actually happened in the Konakbaev fight: Breland was then nineteen years old, fighting in the finals of his first international competition. Konakbaev dominated the first round, scoring with left hooks to Breland's head and, when the American raised his guard, with jabs to the body. When Breland returned jabs, Konakbaev, in a boxing style more characteristically American than Soviet, danced out of range or ducked under the blows. By the end of the round Breland had analyzed the Russian's unanticipated technique and had adjusted. His jabs began to connect. Midway through the second round Breland caught Konakbaev lowering his left hand and threw three quick, explosive rights over it, dropping the Russian to the canvas. For the remainder of the bout Konakbaev fought diffidently, and Breland won by a unanimous decision.

Two years later Breland's reputation as a fighter continues to grow. Few boxers have ever combined such raw physical capacity with the perspicacity and resolution one sees in his boxing performances. In the upcoming Olympics, Breland is the standout talent on an American boxing team that can realistically expect to win eight or nine medals. His right cross is arguably the most powerful punch in amateur boxing, having been responsible for nearly all of the

seventy-one knockouts that he has recorded in his 103 victories (out of 104 fights). That straight right by itself would be sufficient armament for most competition, but Breland has more. He supplements his powerful right with refined tactical skills matched to his physique. At six feet three inches he is unusually tall for the 147-pound welterweight division, but he has a long, slender torso and wide hips, and thus a low center of gravity, which provides him



with excellent balance. He can weave under and around punches, sometimes ducking beneath blows thrown by fighters a head shorter, and he can return punches from a range of seemingly impossible positions. Rather than using his reach advantage to keep opponents at a distance with a pecking jab—a tactic of many tall fighters—Breland feints and traps to lure opponents within range and off balance and then uses his height as leverage to whip power into his punches.

Boxing pundits are already comparing Breland to Muhammad Ali, Sugar Ray Leonard, and even the hitherto unparal-

leled middleweight Sugar Ray Robinson. The last comparison makes sense: at the age of twenty-one Robinson had a build similar to Breland's: tall and slender, with a long neck heavily muscled from exercise. Robinson delivered similar power with his right hand, though he had a destructive left hook, a punch Breland has yet to develop fully.

Even before the Konakbaev fight Breland had exhibited the talent needed to fight professionally and win. However, he understands the lesson learned by several U.S. boxers after the 1976 Olympics: a gold medal is worth considerably more than a score of conventional paydays. Sugar Ray Leonard set the example: on the strength of the flash and presence he demonstrated in Montreal, he earned \$3 million, and a title fight that would pay \$1 million more, within three years of his Olympic triumph. By then he was twenty-three years old. Breland is looking for the same success. During his patient wait for the Los Angeles games he has accumulated an unprecedented five New York Golden Gloves amateur-boxing titles. He has already started a secondary career, costarring in the motion picture *The Lords of Discipline* and winning critical acclaim. And he has become the athletic focus of his home town, Brooklyn, which has in a sense been waiting for a local hero ever since the days of Floyd Patterson and the departure of the Brooklyn Dodgers.

BRELAND IS A child of one of Brooklyn's most impoverished slums, the Bedford-Stuyvesant area. He is the fourth of six children born to a nursing-home attendant and a construction worker. At age seven Breland went with a family friend to see Muhammad Ali fight and lose to Joe Frazier in Madison Square Garden, and that began his infatuation with both Ali and boxing. The following year Breland walked into the old Broadway Gym in Brooklyn and began learning the sport from a bearish man named George Washington, who was a former sparring partner of Joe Louis's. (Both Breland and Washington are now at a nearby gym run by the Bedford-Stuyvesant Boxing Association.) For the next several years Breland learned from Washington and studied films of Robinson and Ali. The films served him as well on the streets as in the ring. Breland recalls his street-fighting episodes as opportunities to practice the dancing and shuffle that were signatures of Ali at his best.

G. A. Taubes is a onetime amateur boxer and a staff writer for Discover magazine.

In the ring Breland spurns showboating and flamboyance for a more aggressive, direct approach. Although the newspaper reports from his early Golden Gloves fights invariably included a cocksure quote (after one bout, in which he demolished the junior Olympics champion, he claimed, "I saw it in his eyes when we were getting our instructions from the referee"), the record—an unbroken string of first- and second-round knockouts—is more indicative of his personality in and out of the ring. Even when he has a fighter hurt, Breland will not show off. He simply fights to end the bout. He does not wade in pell-mell with a barrage of blows. The denouement is thought out and tactically concise: always on balance, Breland will hook or feint to the opponent's midsec-

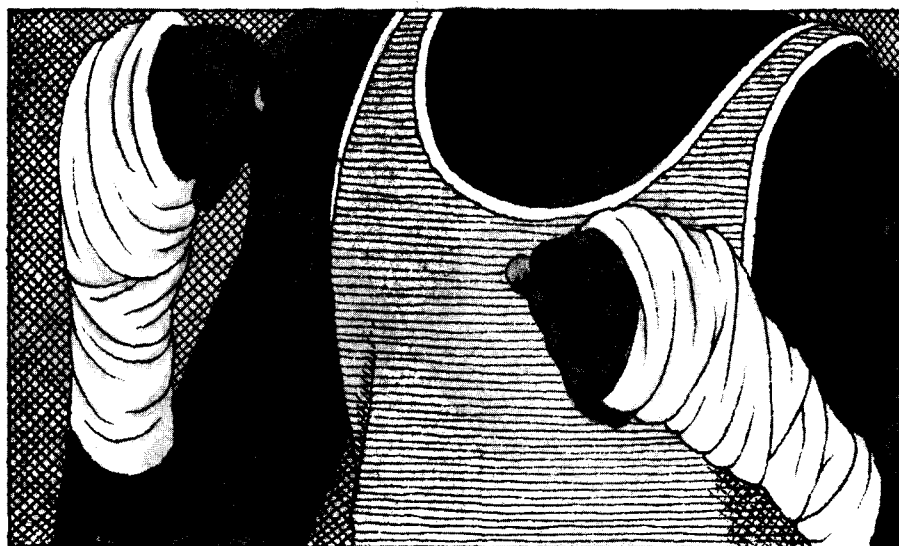
fore Breland even had time to pull his hand back for another blow). Breland's arms are so long and slight that the power in his right crosses seems almost magical. He attributes the snap and force of his punches to the flexibility he maintains through yoga and stretching.

Partly because of his innate coordination and reflexes and partly because of his intelligence and willingness to learn, Breland gets away with moves that would be dangerous for other fighters. Because of the way he taught himself, many of his tactics, unsurprisingly, remind boxing fans of Ali in his prime: in particular the way Breland holds his left hand low, exposing his head to lure cautious opponents into his range. Ali described the technique in his autobiography, *The Greatest*: "I learn to put my head

ring. A casting director from Paramount saw his photograph in the newspaper and was struck by his stark good looks. She offered him a role in *The Lords of Discipline*, and he accepted with the alacrity of any eighteen-year-old discovered by Hollywood. In the film Breland plays Pearce, the first black cadet at a southern military academy that is unofficially bent on continuing as an all-white institution. Pearce is subjected to brutal hazing and then torture at the hands of his fellow cadets. The role of a strong, silent man-child who resolutely takes what the world dishes out and still triumphs was a familiar one to Breland after his youth in Bedford-Stuyvesant. Although the film role did not demand a broad range of emotion, he performed with dignity and little self-consciousness.

Breland has not significantly changed his life-style in the past few years—he still lives with his family in a low-income housing project—but the film and his accomplishments in the ring have led to celebrity, with all its attendant drawbacks. He is followed and watched wherever he goes. His morning runs through Prospect Park have become group affairs involving neighborhood youths; his afternoon workouts are attended by an audience of curious well-wishers. As was the case with the United States Olympic hockey team, he must live with the expectations of friends, strangers, and an entire country. Breland handles the growing pressure with calm humor and with subtle sophistication about the dangers of wealth and success. He is managed and trained by people who give him both shelter and guidance.

To avoid the more insidious temptations of fame, Breland employs a fail-safe technique—train harder. A year and a half ago, a distressing lack of sparring partners in New York led him to begin working out when possible in Detroit, at the Kronk Gym. Under the supervision of the trainer Emanuel Steward, Breland spars with a stable of professional fighters that includes Milton McCrory, the World Boxing Council welterweight champion, and Thomas Hearns, the World Boxing Council super-welterweight champion, both tall, angular fighters like Breland. His showings against both (he knocked McCrory down and fought evenly with Hearns) lead him and Stewart to believe that if Breland were fighting professionally, he would be the top-ranked fighter in his weight class.



tion, knowing that a hurt fighter is more likely to fall for the feint and drop his hands. Then Breland fires a right to the head.

That right is a textbook-perfect blow. Unlike most fighters, who cock the right hand and begin the punch with a noticeable movement of the right shoulder, Breland begins his punching motion below his waist, imperceptibly pivoting his right foot and hip. The resultant whip-lash action carries through to his hand, which has the weight of his body behind it when it is launched from its position at mid-chest, level with his heart. Either Breland will slip to his right and then cross over, down, and through with the punch, which impacts at full arm extension, or he will step inside the opponent's punches to counter with a shorter blow (a Romanian fighter in the 1982 world championships, hit with that short right, landed abruptly on the canvas be-

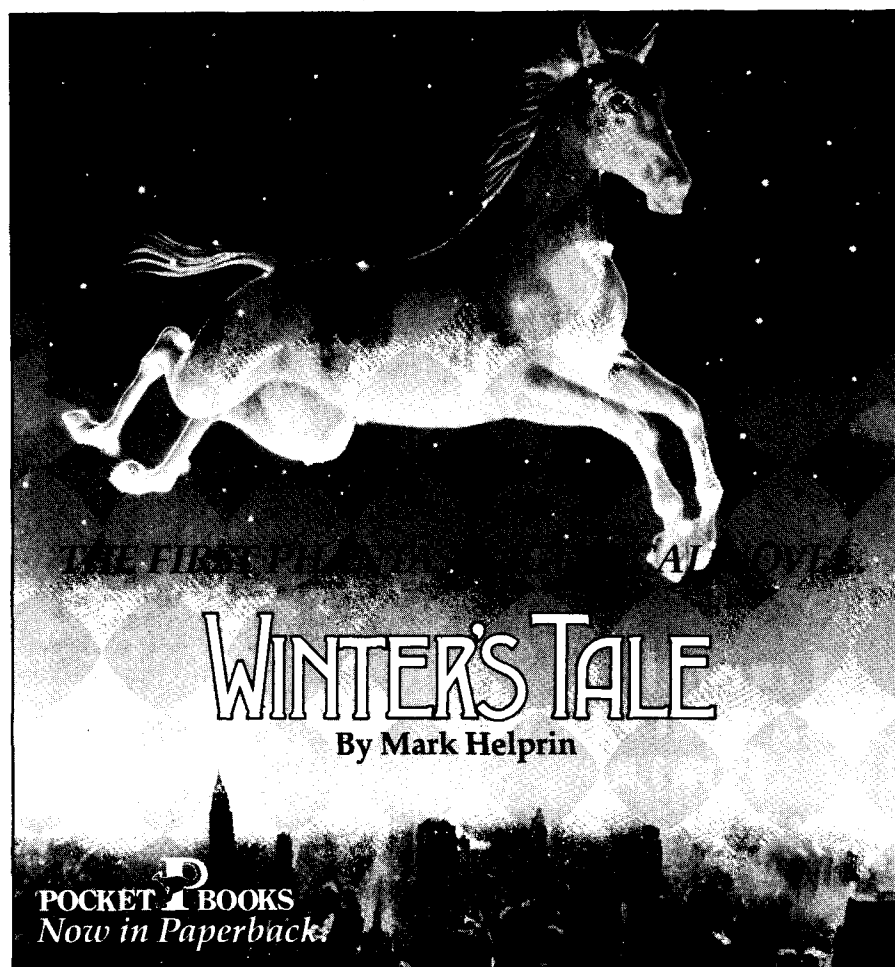
within hitting range, force my opponent to throw blows, then lean back and away, keeping eyes wide open so I can see everything, then sidestep, move to the right, or to the left, jab him again, then again, put my head back in hitting range." Such watchfulness, which Ali called a "built-in radar," is Breland's ultimate defensive and offensive weapon. With it he can evade blows, or parry them with his gloves or shoulders and counter while his opponent is still vulnerable. Breland is so aware of what happens when he boxes, his trainers say, that he fights as though he had a coach in the ring with him. He never makes mistakes twice, and he can diagnose an opponent's style and adjust accordingly within a minute.

ALITTLE MORE THAN two years ago Breland proved that his ability to learn and adapt extends outside the

His primary concern now is to develop his left hook into a weapon as devastating as his straight right. The concern is born of necessity: because of the force with which he punches, he severed two tendons on the knuckle of the index finger of his right hand, an injury that required surgical reattachment in June of 1983. Breland insists that the hand no longer bothers him, but he realizes that he will need a second punch with knock-out power, if for no other reason than to forestall further problems with his right hand.

Breland's most rigorous test thus far will come in the Olympics, where he will have to fight half a dozen times over a period of two weeks. In the absence of Soviet-bloc boxers, however, Breland should not have to face stiff competition. The only two fighters known to be of Breland's caliber are the Russian Konakbaev and Candelario Duvergel, a Cuban. Konakbaev may be Breland's equal in fighting savvy, but he lacks Breland's power, and seemed unlikely to do better than he did in 1982. Duvergel is the best combination boxer and puncher on his national team. He is a clever fighter and an excellent counter-puncher who uses feints and uppercuts—but he, too, has already been defeated once by Breland.

Breland and Shelly Finkel, a New York rock promoter and boxing manager who will become Breland's manager after the Olympics, are planning a professional debut in Madison Square Garden in November, regardless of the outcome of the Olympics. To enhance Breland's popularity, Finkel hopes to find a commercial sponsor for the fight and says that with or without one he will offer the 20,000 seats of the Garden free to local fans. Emanuel Steward, who, with George Washington, is likely to train Breland after the Olympics, predicts that Breland will be ready for a title fight in the welterweight division after, at most, two years of professional bouts. Eventually Breland will add muscle to his frame and move up to middleweight. Breland's long-range plan, which is as aggressive as his boxing, is to fight for no more than five or six years—during which he might become the richest prizefighter ever—and then turn to full-time acting. Although he loves prize-fighting, Breland would prefer a career in which, as he puts it, no one is trying to hit him in the face. If his record so far is any indicator, we must assume he will get what he wants. □



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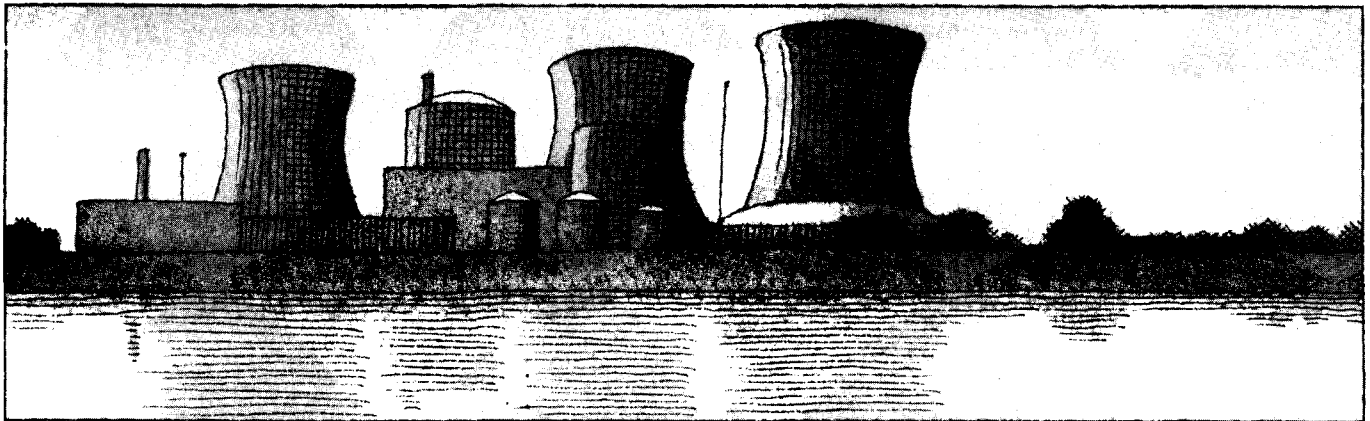
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BOOKS



LOOSE TALK ABOUT NUCLEAR POWER

BY RICHARD WILSON

THE CULT OF THE ATOM
by Daniel Ford. Simon and Schuster, \$6.95.

THE WAR AGAINST THE ATOM
*by Samuel McCracken. Basic Books,
\$18.50.*

HOW SAFE IS NUCLEAR ENERGY?
by Sir Alan Cottrell. Heinemann, \$6.00.

URANIUM-235 CAN generate three million times as much energy as an equal weight of coal can. Its fecundity is the source of almost all of the advantages and disadvantages of nuclear energy. Used as fuel, uranium can supply the world's needs for 100,000 years; used as an element in bombs, it has an explosive power millions of times greater than that of dynamite. Few technologies have raised as much controversy as nuclear electric power has. More than a hundred books have been written on the subject; these three are representative of the spectrum of opinion.

Daniel Ford was from 1973 to 1979 the executive director of the Union of Concerned Scientists (UCS), a public-policy group based in Cambridge, Massachusetts, that has been sharply critical of the nuclear industry. In Ford's view, the U.S. nuclear-power program is "the most ambitious, expensive, and risky in-

Richard Wilson is the Mallinckrodt Professor of Physics and the chairman of the physics department at Harvard University.

dustrial venture ever undertaken." Samuel McCracken was a senior research fellow at the Center for Energy, at Boston University, and is now an assistant to the president of that university, John Silber. McCracken concludes that "nuclear energy is environmentally the most benign of major energy sources except natural gas, the most benign in terms of public health [and] major accidents, and the only major source able, over a long period of time, to give us large amounts of flexible energy." Sir Alan Cottrell, a metallurgist, was the chief scientific adviser to the British government from 1971 to 1974. He states his position—more optimistic than Ford's and more conservative than McCracken's—thus:

I am in principle in favour of nuclear energy because I do not think that the coming multitudes can survive the bitter winds and sunless winters of the next century without it. . . nuclear energy *can* be made a sufficiently safe form of energy, certainly much safer than any realistic large-scale alternative.

Whether it *will* be safe in practice is an entirely different matter.

Confronted with such widely divergent assessments of nuclear power's safety, the public understandably tends to cast its lot with the skeptics, on the side of caution. And given the lack of popular support for nuclear power—indeed, the vigorous opposition of some groups—the utilities themselves are losing interest. They have placed no new orders for nuclear plants since 1978 and have canceled plants under construction. Although countries less rich in energy than the United States—Japan, France, Germany, and England, among others—have not canceled their nuclear

programs, the American nuclear industry has long since been declared dead by business commentators. Unfortunately, few people have bothered to look past the results of the debate over nuclear power to its content. Often, technical information that appears to transcend politics has in fact been subtly—or not so subtly—manipulated. Moreover, such distortions occur on both sides of the question. The books by Ford and McCracken are cases in point.

FORD CONCENTRATES ON the regulatory process—on the government's attempts to define an adequate degree of safety and to ensure that the nuclear industry achieves it. His book, the new edition of which (revised and expanded in paperback) has not been changed substantially, is detailed and well documented as far as it goes, but it ignores facts that belie its thesis.

Ford's discussion of the hearings on emergency core-cooling systems which the Atomic Energy Commission (AEC) conducted in 1972 and 1973 illustrates a pattern of omissions that runs through the book. He should be aware of all the criteria that the AEC considered, because for the two years of the commission's deliberations he served as technical interrogator for the UCS and other groups at the commission's public hearings. The scientific issue before the AEC was whether or not emergency core-cooling systems could be depended on. Their reliability is crucial to the prevention of a meltdown. Ford states, correctly, that "industry designers had attempted to make what they termed 'conservative assumptions'—to err on the safe side." The nuclear industry had long believed that fuel rods could be

heated to as high as 2,700 degrees Fahrenheit for short periods without risk of an accident, and that in any case the water in the cooling system would prevent the temperature of the rods from ever rising above 1,600 degrees. In 1967, as orders for nuclear plants increased substantially, the AEC began a research program to investigate the industry's assumptions. The first tests were conducted on such a small scale that their results could not realistically be extrapolated to the activity of a full-size reactor, but they were distorted in the direction of pessimism rather than optimism. The tests showed that various obstacles to the flow of coolant might exist in the design of the reactors then in favor, and the investigators feared that if a bad pipe break occurred in such a reactor, the temperature of the fuel rods would rise higher than the 1,600-degree maximum anticipated by the industry. Moreover, the tests showed that oxidation and embrittlement of fuel can occur at temperatures much lower than the 2,700 degrees that the industry believed to be safe—as low, in fact, as 2,300 degrees.

In 1971, when several large reactors were nearing completion and their owners were applying for licenses, the AEC asked Stephen Hanauer, a professor of nuclear engineering at the University of Tennessee, to head a task force to recommend new criteria for the plants' fail-safe systems. Hanauer reported orally to the AEC (a political mistake), and on the basis of his counsel the commission released interim criteria for acceptable emergency core-cooling systems. Nowhere does Ford say that these criteria were more stringent than those previously imposed on the industry, though they were. The task force proposed that manufacturers should assume that the most dangerous pipe break that could occur *would* occur, and should design their reactors so that the temperature of the rods would not exceed 2,300 degrees in the event of such a break.

For two years the AEC held hearings to learn whether or not these guidelines were stringent enough. Philip Rittenhouse, a metallurgist at the Oak Ridge National Laboratory, in Tennessee, and the head of an AEC reactor-safety research program, suggested that they were not. Rittenhouse had studied the worst-case estimates, and testified that he thought the research was inadequate to justify the criteria. Ford's account of Rittenhouse's comments is unduly pessimistic. After questioning, Rittenhouse

refused to discuss specific criteria that he thought *could* be justified by the research that had been done, because, he said, such advice was not within his expertise. Ford writes as if Rittenhouse had argued that no such criteria could be devised that would make reactors safe. It is an elementary principle of nuclear technology, however, that the less power a reactor generates, the wider its margin of safety. Rittenhouse simply left it to others to state precisely what the optimum power level should be.

Ford states that the final policy for emergency core-cooling systems, adopted in 1974, left the AEC's 1971 interim policy essentially intact. That is false. On the recommendation of scientists at the Argonne National Laboratory, near Chicago, the maximum allowable temperature was reduced further, to 2,200 degrees, and this temperature was permitted only for periods of a few seconds. The assumptions on which the Argonne scientists based their calculations of the new limit were more conservative than Hanauer's, such that the objections raised by Rittenhouse were rendered moot. Moreover, the nuclear industry on its own redesigned the fuel-rod array to ensure that the actual maximum temperature would be even lower than the maximum decreed by the AEC.

All of this was history by 1974—years before even the first edition of Ford's book was published. Ford does not say whether research completed since 1974 confirms or refutes his negative assessment of the reliability of emergency core-cooling systems. In 1978, when researchers at the Department of Energy's laboratory drained fluid from the operating core of a test reactor in order to evaluate the performance of emergency core-cooling systems, that reactor's system worked better than the pessimistic analyses had suggested. Even the interim criteria of 1971 were found to be adequate for safety. They proved to be as conservative as Hanauer had claimed, and the maximum safe temperature of a reactor's fuel rods proved to be higher than Rittenhouse had believed. In February of 1979 the UCS, with Ford still an influential member, sent out information claiming that the system had failed the test; in his book Ford does not mention that the test was ever conducted. Robert Budnitz, the director of nuclear-regulatory research for the Nuclear Regulatory Commission (NRC) from 1979 to 1980, says that he knows of no responsible scientist who *doubts* that the

system, if it is ever activated, will work as it was designed to do.

Ford's other chief target is an independent study of reactor safety published by the AEC in 1974. It is often called the "Rasmussen report," after the study's director, Norman Rasmussen, a professor of nuclear engineering at the Massachusetts Institute of Technology. Rasmussen considered two types of reactors, one built by General Electric and the other by Westinghouse, because these manufacturers enjoyed the largest share of the reactor business. He used "event-tree" analysis, a procedure for charting the various sequences of events that could follow the breakdown of a given component in a reactor. Because each sequence of events arising from a specific breakdown has different outcomes, depending on whether or not the safety systems called into play work, when the sequences are plotted together they resemble the branches of a tree. At each branch Rasmussen attempted to estimate the probability of failure. The probability of a total breakdown of the reactor and its emergency systems is the product of all of these contingent probabilities.

The Rasmussen report is monumental in scope, but it was produced in a hurry, with inadequate attention to clear writing. It has a number of errors of enthusiasm, not the least of which is the fact that the executive summary does not summarize the conclusions of the report itself. Although Ford is right that the report was praised by its supporters beyond its merits, he and many other critics have damned it beyond its deserts. As a result, very few people in the United States have taken the report or its methods seriously.

At the urging of Congress the NRC in 1977 called for a review of the reactor-safety study. A group under the direction of Harold Lewis, a professor of physics at the University of California at Santa Barbara, concluded that the Rasmussen report's numbers were more uncertain than the report had stated and that American water-cooled reactors might be either safer than the numbers suggested or less safe. But Lewis's group also concluded that

- [The Rasmussen report] was a substantial advance over previous attempts to estimate the risks of the nuclear option. The methodology has set a framework that can be used more broadly to assess choices involving both technical consequences and impacts on humans.

- [The Rasmussen report] was largely successful in at least three ways: in making the study of reactor safety more rational, in establishing the topology of many accident sequences, and in delineating procedures through which quantitative estimates of the risk can be derived for those sequences for which a data base exists. . . .

- Despite its shortcomings, [the Rasmussen report] provides at this time the most complete single picture of accident probabilities associated with nuclear reactors. The fault-tree/event-tree approach coupled with an adequate data base is the best available tool with which to quantify these probabilities.

Ford does not quote these positive statements; he simply mentions that the uncertainties were greater than Rasmussen thought.

Although only a few scientists attempted to use Rasmussen's procedure (now called "probabilistic risk analysis," or PRA) in the years following the report's publication, the accident at Three Mile Island indirectly vindicated it. Hours after that accident occurred, many reactor-safety experts realized that no one had studied reactors made by Babcock & Wilcox (like the one at Three Mile Island) as thoroughly as Rasmussen had studied reactors made by General Electric and Westinghouse. If Babcock & Wilcox, or General Public Utilities, which owns the Three Mile Island plant, or the NRC had applied Rasmussen's technique to the reactor at Three Mile Island, they would have discovered that two steps in one event tree were coupled. The failure of one device was not isolated; it automatically caused the failure of another. This flaw, together with certain unusual design characteristics of the reactor's steam generator, created an accident probability a thousand times greater than that of the reactors designed by Westinghouse. (The configuration of reactors designed by General Electric is such that the probability of an accident like the one that occurred at Three Mile Island is zero.) One simple change in the Three Mile Island reactor's controls (which was made in all Babcock & Wilcox reactors six weeks after the accident) would have reduced the probability of failure by a factor of thirty or more.

Ford makes much of the fact that at Three Mile Island a large fraction of the gases krypton and xenon escaped, but he does not say that these are inert and not as hazardous to human health as oth-

er radioactive gases are. He also neglects to say that only one millionth of the radioactive iodine and cesium in the reactor—chemically active elements that can persist in the body—escaped. It is likely that even if the accident at Three Mile Island had progressed to a meltdown, little free iodine or cesium would have been released into the environment. Research is under way to see if accident scenarios for all other designs entail a similarly low risk. If they do, an accident at any of the existing nuclear reactors would entail no more casualties than a bus collision. Why is this relatively reassuring information not reported more often?

The accident at Three Mile Island convinced regulators of the usefulness of PRA, and in the years since, twenty nuclear plants have been subjected to such analysis; studies of eight more are under way. The procedure is also being used to alert operators to the sequences of events that can lead to accidents. It is sad that public criticism of the Rasmussen report polarized the larger debate over safety and delayed responsible use of Rasmussen's method.

Even if all of Ford's charges were true, and nuclear scientists, engineers, and regulators lived up to his caricature of them as bumbling oafs, Ford would not have proved that reactors are dangerous. To make such a case he can cite only the conclusions of a report on the probable consequences of severe nuclear accidents which was written for the AEC by Brookhaven National Laboratory in 1957 and a partial revision of that report, submitted in 1965. If Ford had acknowledged any of the more recent calculations made by Rasmussen and others, he would have been forced to contradict his thesis. Current data show that the consequences of even the most severe accidents would be far less dire than those predicted by Brookhaven.

SAMUEL MCCrackEN is an ardent nuclear enthusiast who is annoyed with the critics of nuclear power: their methods, successes, and factual errors. The most interesting part of his book is his debunking of spurious claims—above all those of Ernest Sternglass.

Sternglass holds a Ph.D. in physics from Cornell University. He has written scientific papers on a variety of subjects, from solid-state physics to diagnostic radiology. For a time he worked at Westinghouse; today he is emeritus professor of radiology in the School of Medi-

cine at the University of Pittsburgh. In a number of reports delivered at public hearings which have been given wide circulation by the press, Sternglass has presented evidence that people living near nuclear plants are dying from cancer at unusually high rates.

Sternglass examined the cancer-mortality figures for Waterford and New London, Connecticut, which are near the Millstone nuclear complex. He found that the rate was greater in 1975, after the first reactor began operation, than it was in 1970, before the reactor began operation. According to McCracken, however, a comparison of the number of deaths from cancer in those communities in 1968 and in 1974 shows that the cancer-mortality rate *decreased* after Millstone began to generate power. As it turns out, neither comparison is statistically significant.

According to Sternglass, the increased cancer-mortality rate was caused by strontium-90 that was released from the nuclear plant and that turned up in the milk produced near Millstone. McCracken, for his part, asserts that the ratio of strontium-90 to strontium-89 indicates that the strontium was the fallout of weapons testing, probably in China, and that it was deposited by rain, more of which falls near Millstone than inland. Moreover, data on the response of people and animals to strontium-90 shows that the amount found in the milk was far too small to cause *any* observable increase in cancer rates.

The public has to be able to distinguish between fact and myth. To that end, the scientific community has a duty to present data accurately. Academic journals rely on peer review, so scientists seldom publicly refute nonsense: the bad research simply goes unpublished. In matters of public policy, however, nonsense can gain a hearing, and scientists must be willing to speak out when it does. Thirteen years ago, when Sternglass was using similar faulty reasoning to show that the fallout of nuclear-weapons tests was killing children, Joseph Rotblat, a professor of physics at London University who abhorred the tests, nevertheless called on his colleagues, in an issue of *The Bulletin of the Atomic Scientists*, to repudiate the incorrect work. To the best of my knowledge, no scientists who are active in the opposition to nuclear power have come forward on their own formally to reject Sternglass's more recent studies. This fact lends credence to McCracken's general charge that the

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critics of nuclear power are more interested in ends than in means.

Unfortunately, McCracken himself does not debate the nuclear question fairly. In his irritation with the critics he often fails to report information that does not serve his purposes. McCracken is particularly weak in his discussion of the proliferation of nuclear weapons. Is it possible to have nuclear power without nuclear bombs? Certainly, history shows that we can have bombs without nuclear power. Many leaders of the anti-nuclear movement (for example, Dr. Helen Caldicott, who was the president of Physicians for Social Responsibility from 1979 until 1983, and Amory Lovins, the director of research at the Rocky Mountain Institute and a consultant to Friends of the Earth) claim that nuclear power makes the spread of nuclear weapons inevitable. But on the other side, many who support a military buildup *also* gloss over the differences between the two technologies. In the 1940s David Lilienthal, who was the chairman of the AEC, tried to persuade the public that research on nuclear weapons would help to promote peacetime atomic power. Apparently, Lilienthal did so in order to justify large military expenditures on atomic science.

McCracken's book, like Ford's, is interesting for its omissions. He points out that Canadian CANDU and British Magnox reactors can be refueled while operating, and can therefore be set up to produce bomb-grade plutonium. Then, reassuringly but incorrectly, he says that "all reactors of this type are currently in the hands of countries that have nuclear weapons or . . . are unlikely to want to acquire them (Canada, for example, or Italy)." India is the only exception, he says. This, unfortunately, is not the case. Pakistan's Kanupp reactor and Argentina's Atucha reactor are of the CANDU type, and neither Pakistan nor Argentina has signed the Nuclear Non-Proliferation Treaty. Israel's Dimona reactor, similar in some respects to the CANDU, is suspected of being used by that country to make bomb-grade plutonium. Because of lapses like these, McCracken's book, like Ford's, is not a reliable source of information about the technology.

SIR ALAN COTTRELL's book is. Impatient with polemics, Cottrell puts into simple and dispassionate terms both the aims and the problems of nuclear energy. According to Cottrell,

a situation so full of fear and confusion that responsible [people] feel compelled to write of "the malignant growth of nuclear power stations" is quite intolerable. The general public is entitled to something better than this—not just to selected facts, which appear to support a particular point of view, but to all the facts sweet and sour. . . .

For readers who want to understand the debate, his book is an excellent resource.

Cottrell is not surprised that the public is afraid of nuclear reactors. The memory of the destruction of Hiroshima and Nagasaki looms large. Moreover, a connection between nuclear power and nuclear weapons does exist. In fact, Cottrell considers it "the one really hard objection to civil nuclear energy." He concludes, however, that weapons proliferation is a political failure that will continue to disturb the world whether or not nuclear power is developed. "As a political problem, it calls for a political solution," Cottrell asserts. (Such advice is especially apposite at this time. The Nuclear Non-Proliferation Treaty will come up for review next year, and it may be weakened or even abandoned. In 1980 seventy-seven countries refused to make the treaty more stringent until the United States and the USSR agree to reduce their stocks of nuclear bombs.)

The effects of radiation on health are another legitimate cause for concern. The data on the consequences of exposure to radiation at the low levels likely to be released by a malfunctioning reactor can never show whether or not a safe dose exists. Therefore, public-health authorities assume that any degree of exposure entails some risk, but that at low exposures the risk is so small that illnesses cannot be directly traced to it. Cottrell demonstrates that the potential emission of radiation by a nuclear reactor is small enough to make the health hazards negligible *if all goes according to plan*.

The track record of the nuclear-power plants that have been in operation since the 1950s should convince us that all usually does go according to plan. The press has tended to report uncritically the arguments of Ford, Sternglass, Caldicott, Lovins, and other anti-nuclear activists, and to ignore information that casts such arguments in doubt. Although reactors are only conditionally safe, depending on the carefulness of their design and operation, we have not done

badly so far. Nuclear power is the *only* energy technology that is not known to have killed a member of the public. No one can begin to make such a claim for coal, arguably the only other source of energy that is plentiful enough to compete.

The continued attention of regulators to the details of servicing and running nuclear plants ought to give us some reason to expect that this record will be maintained. □

AN OBSCURE LIFE

BY PHYLLIS ROSE

THE LETTERS OF JEAN RHYS
edited by Francis Wyndham and
Diana Melly. Viking, \$22.50.

ANYONE WHO LIKES Jean Rhys's novels (as I do) will love her letters. The "heroine" of the letters is passive, fragile, helpless, depressed, angry, more than slightly paranoid, and alcoholic—very much like the heroine of the four elegant novels that Rhys published from 1928 to 1939 in the first phase of her eccentric literary career. (Those novels were *Quartet*, *After Leaving Mr. Mackenzie*, *Voyage in the Dark*, and *Good Morning, Midnight*. Her next—and last—novel, *Wide Sargasso Sea*, did not

appear until 1966, when Rhys was seventy-six.) In the letters as in the novels the Rhys heroine, convinced that the world is against her, battles loneliness and despair, and loses. Like the novels, the letters are lyrical riffs on dark themes, with occasional flashes of gallantry and wit. The difference? The victimized woman of Rhys's novels is just that and no more; in the letters she is also an artist.

The young Jean Rhys was a chorus girl in London and a demimondaine in the Paris of the 1920s. She was involved in a complex intrigue with Ford Madox Ford and his wife, fictionalized in *Quartet*. Her life in her twenties and thirties, as revealed in the autobiographical novels, bears a remote resemblance to Colette's. The locales were similar. Rhys, too, lived marginally, and she struggled, less successfully than Colette, for independence from men. But the story of Rhys's fifties and sixties, as revealed for the first time in these letters, resembles the life of no other woman writer I know. Most writers build on a success such as Rhys had in the 1930s; Rhys disappeared. She lived obscurely in the country with her second husband, Leslie Tilden-Smith, a publisher's reader, until he died, in 1945. Thereafter she married his cousin, Max Hamer, a solicitor, and lived obscurely with him. She allowed herself to be swallowed up in English tackiness. She was poor. She was too numb and hopeless to write. Her "fierce boiling hatred of this dirty mob" (English middle-class Philistines) could not be contained. An upstairs neighbor was rude to her, she slapped him, he charged her with assault, and she spent five days in Holloway Prison. You have to admit that this is a long way from Virginia Woolf.

In 1949 an ad in the *New Statesman and Nation* asked for information about Jean Rhys. It was placed by Selma Vaz Dias, an actress who had adapted *Good Morning, Midnight* for radio. She needed permission from Rhys or her estate to broadcast it; she assumed that Rhys was dead. Rhys answered the ad herself, reestablishing a kind of contact with the literary world, but people continued, eerily, to think her dead. Her next-door neighbor spread the word that she was a fraud "impersonating a dead writer called Jean Rhys." In 1956 a Miss Smith inquired about copyrights, again assuming Rhys was dead. "I don't know why Miss Smith & Co thought I was dead," Rhys responded. "It does seem more fit-

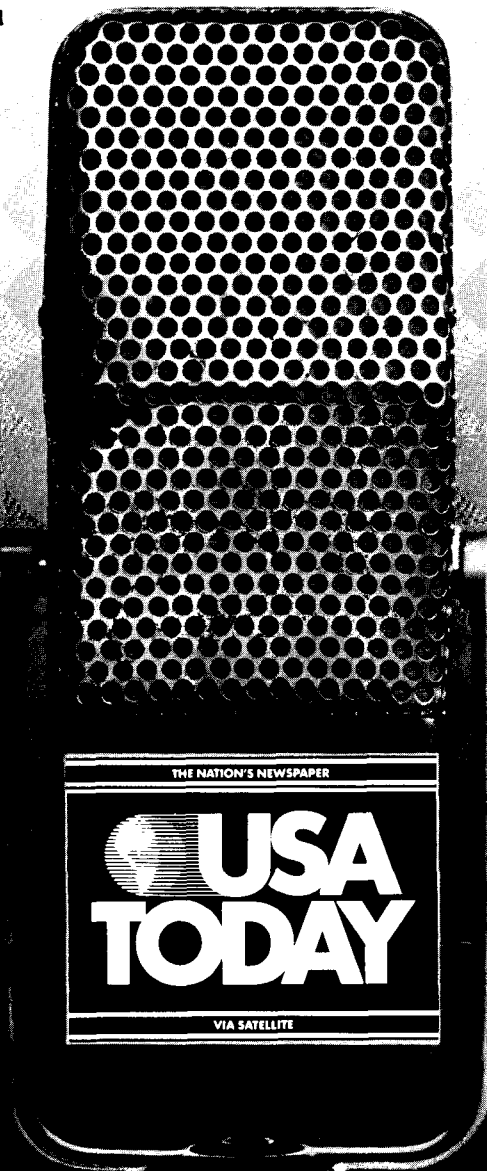


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. . . AND OTHER FINE
RADIO STATIONS
ACROSS THE COUNTRY.

ting I know, but life is never neat and tidy. I feel a bit like poor old Rasputin, who was poisoned, stabbed in the front and shot in the back but was still alive kicking and crowing when flung out into the snow."

Nothing went right for Jean Rhys. When her work was finally read on the BBC, there was a power failure in her village and she couldn't hear it. More serious, in 1949 Max Hamer was caught embezzling. He was tried and sent to Maidstone Prison. Jean Rhys had watched him head toward his downfall but had not known what to do about it. Max looked like a sensible man of business; she looked like a madwoman. If she had said something was wrong, no one would have believed her. So she went "all of a doodah" and started to drink. While Max was in prison, she stayed near him in Kent. Their life after that was a succession of moves from one uncomfortable and dreary residence in the country to another. One cottage was so damp that toadstools grew on the kitchen walls. "When slightly tight I can relax—also there are red letter days when I feel that after all I'm as much fun as the next woman really. However this doesn't happen often."

ALL THIS READS like a Rhys novel. It is not the only one embedded in *The Letters of Jean Rhys*. Another one focuses on the writing of *Wide Sargasso Sea*, which took almost a decade. Max was sick. Rhys took care of him by day and worked by night—powered by speed and booze. The neighbors thought her a witch. She struggled with self-doubt, yet was fiercely determined to get the book written: "I think I have some reserves of strength. It is only outwardly that I'm a lightweight person." When Max went into the hospital, things got no easier. She was oppressed by loneliness and self-pity. She hated Cheriton Fitz Paine, the village that fate had brought her to. It was isolated, graceless, intolerant, and without typists. The lack of typists was a real problem in producing her novel. She wrote drunk, revised sober. The manuscript was messy. She could not pull it all together, could not pull herself together. She received £25 from the publisher André Deutsch in exchange for an option on the novel, and this meager sum provoked terrible guilt. She apologized con-

tinually for not getting on with it more quickly. But this story, unlike most Jean Rhys narratives, had a happy ending. For she did finish *Wide Sargasso Sea*, and it was worth the trouble. It is a lush historical novel about a West Indian beauty married off to an Englishman who, fearing her mystery and sensuality, locks her up as mad; it is a retelling of *Jane Eyre* from the point of view of Rochester's wife. It is also Rhys's spiritual autobiography: born on Dominica, in the West Indies, she was transplanted to England at the age of sixteen. She suffered for the rest of her life from the actual and metaphorical cold and from the sense that most English people thought her mad.

These letters establish once and for all Jean Rhys's seriousness as a writer. Even her most devoted readers may sometimes have wondered whether the novels—so close to her life—were written or merely exuded. The letters prove that the novels were written, shaped, crafted, and did not just ooze from her experience. They also show her to have possessed a moving belief in the importance of the literary enterprise and the insignificance of any one practitioner of it: "I don't believe in the individual Writer so much as in Writing. It uses you and throws you away when you are not useful any longer. . . . Meanwhile there is nothing to do but plod along line by line. Then there's a drink of course which is awfully handy." The most characteristic and endearing of her statements about the dignity of art are followed by some such reference to the glories of whiskey, or they execute a Rhysian pirouette into whine—more than a hint that the world should have treated her better. ("The writer doesn't matter at all—he is only the instrument. But . . . he must not be smashed. . . . No music if you smash the violin.") Her life seems at times so ghastly, so lacking in minimal comfort and joy, that one wonders what kept her going. The answer is Art. "For I know that to write as well as I can is my truth and why I was born. Though the Lord knows I wish I hadn't been!"

Rhys's letters have something of the immediacy and fluidity of Virginia Woolf's, although they are less gorgeous. She moves, for example, from a complaint about confusing street signs in Penge to a description of the trees there, which "have all been lopped so that they look like badly done poodles. A bit ashamed. It is terrible what they do

Phyllis Rose's most recent book is Parallel Lives: Five Victorian Marriages.

to trees. Why? Can you tell me? I've an idea (another of my ideas) that some men are jealous of trees and love making them look ridiculous." There's an off-balance, scat-singing rhythm to her epistolary prose. Her fear and hatred of the English, her sufferings from the cold, form a bass line underlying happier strains, such as her enjoyment of beauty in many odd forms. Occasionally she can even muster some humor.

I am writing this after a fierce dispute about a clothes line made of *barbed wire* just outside my sitting room window.

I can't imagine what they hung on it. Coats of mail I suppose. Very useful too.

The horrible thing is gone, but I've made six enemies—at least.

There is also a perfectly terrible bed of old cabbages which I'm trying to root up. My neighbours detest me because they think I'm putting on airs.

Some of the best and bravest letters are to her daughter (by her first husband), Maryvonne Moerman. With her husband and young daughter, Maryvonne lived for a while in Indonesia, and Jean Rhys wrote consoling her on her sufferings from heat and complaining about her own sufferings from cold. She advised Maryvonne on how to kill cockroaches, by mixing sugar with boracic powder. (They can't resist the sugar, and the boracic powder gets them.) Always changing addresses and unable to send nice presents, Rhys felt she made a "not very satisfactory granny" and mother. Still, she was a granny; she was a mother. Her daughter evidently cared for her. So did her husbands. And she for them. We can relax. Life was not quite so grim for Jean Rhys as it was for Sasha and Anna and Julia, of her early novels.

Rhys's autobiography, *Smile, Please*, unfinished at the time of her death, in 1979, and published a year later, told us none of that—nothing about her husbands or her daughter or her dedication to her writing. It was a poor book, produced when Rhys was in her eighties and often drunk. It disappointed anyone who hoped to learn from it the story of the mysterious lost years between the publication of *Good Morning, Midnight* and that of *Wide Sargasso Sea*. Happily, her letters serve to tell that story, and, in a manner characteristic of Jean Rhys's art, the story is both depressing in content and exhilarating in its effect. □

BRIEF REVIEWS



THE NIGHTMARE OF REASON: A Life of Franz Kafka by Ernst Pawel. Farrar, Straus & Giroux, \$25.50. A reader of Kafka's letters and diaries, still more of his tormented fiction, is likely to picture the author as an impractical, harried blunderer and bumbler in the everyday world. Without in the least minimizing the neurotic conflicts that stimulated Kafka's creativity while raising havoc with his personal life, Mr. Pawel reveals that his subject was a thoroughly efficient public servant, highly regarded by his superiors, regularly given promotions and salary raises, and when his health failed, treated with exceptional consideration for the time and place. During the First World War, Kafka did such good work in arranging the treatment of disabled and shell-shocked veterans (for whose care the Austrian government had made no advance preparation worth mentioning) that he would have received a medal had the Hapsburg Empire not collapsed while the award inched its way along the red-tape route. How, one wonders, would Kafka, with his apprehensive resentment of all organized authority, have accounted for a medal? Mr. Pawel does not speculate on that point. Indeed, he keeps speculation to a reasonable minimum throughout this admirable biography, relying instead on documents, letters, and reminiscences to re-create both Kafka and the precariously balanced Jewish-German-Czech society in which he lived.

MAGNIFICENCE AND MISERY by E. Hazard Wells. Doubleday, \$17.95. Wells went to the Klondike, not for the first time, in 1897, to report on the gold rush for the *Cincinnati Post*. He meant to strike a bit of gold himself, if possible, but did not mention that in his dispatches, which were full of lively detail on prices, shortages, transport, weather, equipment, the dangers of the trail, and the imminence of famine. A lamp worth \$1.00 in Cincinnati went for \$7.50 in Dawson, with men vainly bidding \$20.00 a gallon for kerosene to light it with. Wells never got around to writing an autobiography. His clippings, photo-

graphs, and miscellaneous papers ended up in a cellar in Seattle, where Randall M. Dodd literally stumbled over their box in 1968. Mr. Dodd recognized a bonanza, and has edited Wells's material into a fine account of a brief but gaudy episode in frontier history.

THE WITCHES OF EASTWICK by John Updike. Knopf, \$15.95. Aside from displaying the author's now predictable Mrs. Grundy view of the world, this novel demonstrates that witches are dangerous company. Even though Mr. Updike himself invented them, the weird sisters have cursed his style with tumidity and his plot with anticlimax.

PASTELS: From the 16th to the 20th Century by Geneviève Monnier. Skira, \$37.50. Ms. Monnier's text and notes provide much information on the technique of pastel and the purposes and opinions of the artists who have used it. The illustrations are magnificent, and the book as a whole becomes a celebration of the wonderfully brilliant and flexible medium of colored chalk.

GEORGE BANCROFT by Lilian Handlin. Bessie Harper & Row, \$24.50. George Bancroft (1800–1891) is remembered as a historian, honored but nowadays unread except by specialists. He was also, as this thoroughly researched biography establishes, an educator, a politician, a shaper of opinion, a moralist, an inept parent, a radical, a conservative, an ambassador, a banker, a social lion, a money-chaser, and, as secretary of the Navy, the founder of Annapolis. A life of Bancroft necessarily includes a large chunk of the political, social, and intellectual history of nineteenth-century America, and Ms. Handlin presents this mass of material with impressive clarity.

LANDSCAPES OF THE NIGHT by Christopher Evans, edited and completed by Peter Evans. Viking, \$16.95. The late Christopher Evans theorized that sleep, a dangerous occupation, is necessary to accommodate dreams, which are the means whereby the brain assimilates its waking intake of information and checks or reorganizes its established patterns of action or knowledge. He compared the activity to the updating of programs in a computer. The text reaches and supports that interpretation through a survey of old beliefs about dreams, modern studies of and experiments on dreamers, and application of the theories of Freud and Jung. Some

of the information is astonishing, some of the animal experiments reported are disgusting, some of Christopher Evans's opinions are refreshingly irreverent, and the argument as a whole is of great interest. It is also notably well written, with no clue to how much of the second half has been elaborated by Peter Evans from notes.

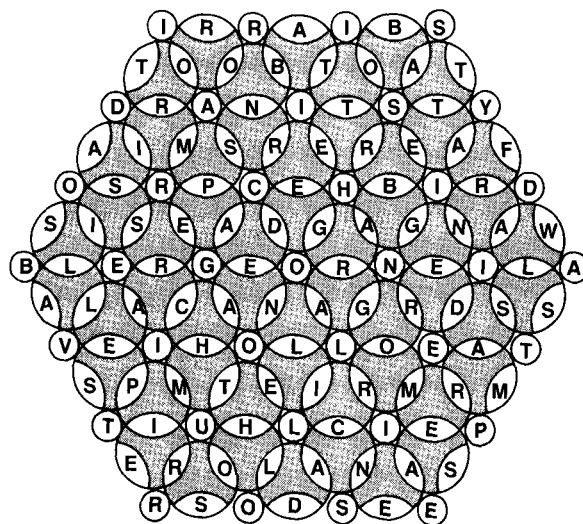
THE ONLY PROBLEM by Muriel Spark. Putnam, \$14.95. Ms. Spark's novel concerns the troubles of two English couples. Their problems begin with money and incompatibility, proceed to infidelity, and arrive at offstage political terrorism. One of the characters is obsessed by the Book of Job, a device presumably intended to give metaphysical significance to the whole affair. It does not, because Job's misfortunes were not of his making, while those of Ms. Spark's quartet are their own invention.

THE ORIGINS OF ENGLISH WORDS by Joseph T. Shipley. Johns Hopkins, \$39.95. Dr. Shipley subtitles his book "A Discursive Dictionary of Indo-European Roots." Discursive is the commanding word in that phrase. Looked up in the index at the back of the tome, it leads one to its primordial ancestor, *Ker(s)*—run, Latin *currere*, and so on through twenty some derivations to corridor. The corridor leads to curse (no kin), Freud, warfare, wagons, the Bible, carpentry, Blake, and Sam Johnson. *Ker(s)* is a modest example of the crop Dr. Shipley can reap from a single root. His book is a word-loving browser's delight, although its information is not infallible. "The Vision of Sir Launfal" is attributed to Oliver Wendell Holmes, although the author knows perfectly well that the poem was written by James Russell Lowell. On the other hand, a man who winds up a small quotation from Keats with "(Read it all)" can be forgiven almost anything.

THE ANNOTATED CASEY AT THE BAT with an introduction and notes by Martin Gardner. University of Chicago, \$6.95. Mighty Casey has inspired more parodies than Hiawatha—no small feat—including Grantland Rice's outraged lament at discovering "a cove who never heard of 'Casey at the Bat!'" In case there are other such deprived persons about, or any umpire-eyed types who missed the original edition of Mr. Gardner's amusing collection of Caseyana, here it is again, taking the field.

—Phoebe-Lou Adams

Answers to the July Puzzler, "GARDEN PLOT"



1. R(I)OT 2. (h)ARBOR 3. B-IOTA 4. STAB (rev.) 5. TRI(A)D (*dirt* rev.) 6. MAROONS (double def.) 7. BITTER-N 8. TO-ASTER 9. F-ATTY 10. O-AS-IS 11. IMPRESS (anag. of *persimmons* minus *mon*) 12. RE(DC)APS 13. HER(BAG)E 14. B(EAR)ING (*are* anag.) 15. DWAR-F (anag. + *f*) 16. (a)SLAB (rev.) 17. R-ALLIES 18. A-CRE(AG)E 19. GR(O)ANED (anag. + *o*) 20. GR-ANGER 21. DENIALS (hidden) 22. S(L)AW 23. VA(L)ES (*vase* anag.) 24. I-(M)PEACH 25. ETHANOL (anag.) 26. GORILLA (anag.) 27. (y)AR(MORE)D 28. MAS(T)S 29. SPITE (anag.) 30. T-HOR(I)UM (*humor* anag.) 31. HE-LICAL (*lilac* anag.) 32. C(RIME)AN 33. SPE(a)RM(int) 34. (b)ERR(y)'S 35. SOLD-O 36. DAN(E)S (anag. + *e*) 37. EASE (hidden)

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ATLANTIC CLASSIFIED

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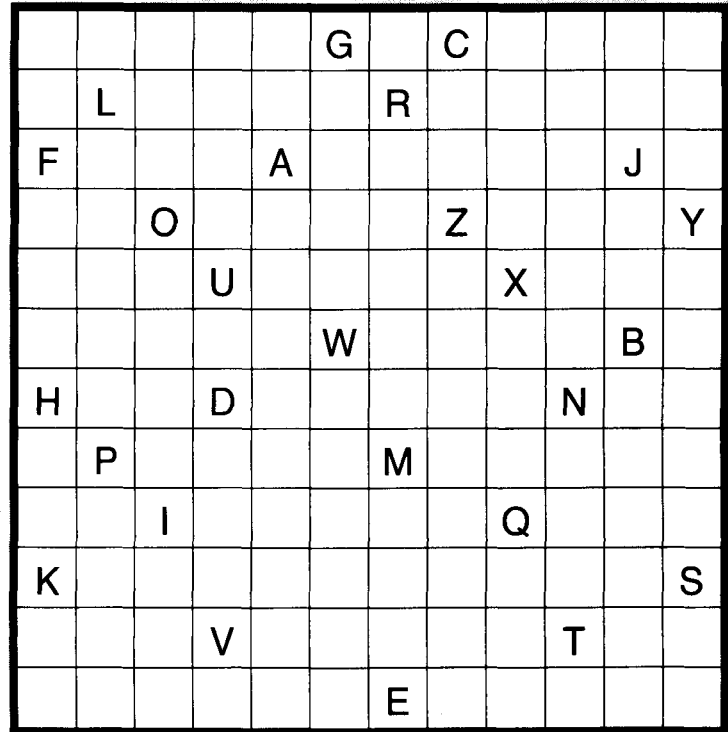
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THE ATLANTIC PUZZLER

BY EMILY COX AND HENRY RATHVON

ABC

The 26 letters of the alphabet have been planted in an otherwise blank diagram. Since the usual bars and numbers are absent from the grid, solvers must use these 26 letters as guides in entering answers to clues. (The clues are listed randomly and are numbered 1–40 simply for convenience.) Some clue answers may not cross any of the 26 planted letters, but in the completed diagram, of course, each of the 26 will be in at least one word. Answers include seven proper words; 15 is uncommon; there is a variant spelling at 16.



*The solution to last month's
Puzzler appears on page 113.*

CLUES

1. Bloke in seaside shelter (4)
2. Turned back a punch in part of California (4)
3. Beyond understanding, love gambling game (4)
4. Laugh at B & O rail rider (4)
5. Russian author left behind disco (5)
6. Japanese beverage's benefits (5)
7. Some horses nibble grass loudly (5)
8. Summer leafage hides blackbird (5)
9. Article about professional cook's garb (5)
10. Rush round with enthusiasm (5)
11. Chinese philosopher stole a cuckoo (6) (*hyphenated*)
12. Someone digging around for fan (6)
13. Watt drawing support for underhanded character (6)
14. Show up with a piece of passion fruit (6)
15. Vegetarian's strange mirage (6)
16. Progress set back in discussion (6)
17. Void surrounding one type of plant (6)
18. Blow shattered rural quiet (6)
19. Overhead train has even number (6)
20. A zinnia's foremost a meadow flower (6)
21. Join Greene, the actor, turning 50 (6)
22. Heard someone lapping booze (6)
23. A Pole's foreign to Texas town (6) (*two words*)
24. Damages about ten saws (6)
25. Skillful, absorbing each loss (6)
26. "Return" summarizes part of a typewriter (6)
27. I pull up with good old Chinese book (6) (*two words*)
28. Miffed to the max, so take it easy (6)
29. Coach in bumpy terrain (7)
30. Scott Joplin piece included in lively Afro medley (7)
31. One bronze boxing heavyweight champ, like Rocky Balboa? (7)
32. Close behind barrier, a marsupial (7)
33. Endurance specialist running start of marathon in modern-day Persia (7) (*two words*)
34. Stirrings drinks boisterously after the first (7)
35. Rap hand, breaking ground (7)
36. Justify conflict with harangue (7)
37. Terribly appealing bonus (9)
38. Scottish king incorporates drill in celebrations (9)
39. Resentment about troubles of rogues (10)
40. Monstrous female French author gets cheese (10)

Note: The instructions above are for this month's puzzle only. It is assumed that you know how to decipher clues. For a complete introduction to clue-solving, send a self-addressed, stamped envelope to The Atlantic Puzzler, 8 Arlington Street, Boston, Mass. 02116.



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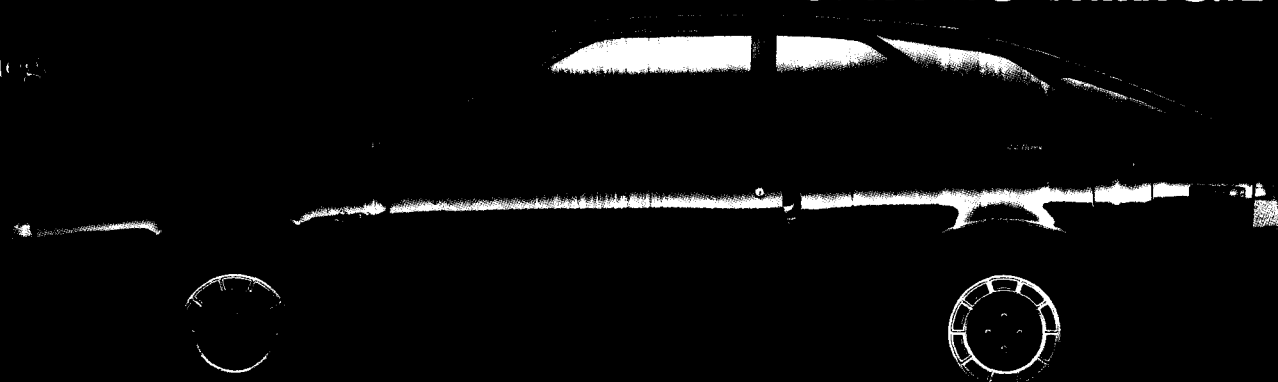
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RENAULT
THE ONE TO WATCH

Fuego





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